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SUGARBEET RESEARCH

1995 REPORT

FOREWARD

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SUGARBEET RESEARCH

1995 REPORT

Section A

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1995

BECKER, J.O., A.F. WRONA, and R.T. LEWELLEN. Effect of solarization and soil fumigation on sugarbeet cyst nematode population, 1993-95. Biol. & Cult. Tests to Control Plant Disease 11: (in press). 1996.

The study was conducted at the USDA Irrigated Desert Research Station in Brawley, CA. The soil at the trial site was a clay loam naturally infested with the sugar beet cyst nematode. The experimental design was a randomized complete block with 4 replications per treatment. Plots were two rows wide and 9.1m long with beds on 0.76m centers. During the summer fallow period between crops, a 0.1mm clear polyethylene tarp was placed flat over the solarization beds. The tarps remained on the beds for 6 weeks. A commercial applicator injected methylbromide/chloropicrin (MBr/Chl, 75%/25%) at a broadcast rate of 392 kg/ha and immediately covered the beds with 0.1mm clear polyethylene tarp. The tarps on the fumigated beds were removed after 3 days. The check plots remained non-treated. Sugar beets were seeded in the beginning of October and standard crop management recommendations were followed. At harvest time, 10 soil samples were taken at a depth of 0-15cm and 15-30cm from each bed. The samples from each depth were pooled and mixed thoroughly in a plastic bag. From each bag, 350g soil were processed for nematode cysts and eggs. After harvest, the trial area was disced and left fallow until the following October. Without any further treatments the trial area was seeded again with sugar beets. At the end of the growing season, the original plot sites were sampled and analyzed for cyst nematodes as previously described.

Pre-plant soil solarization and soil fumigation had only a rather small effect on the cyst nematode population found after the first season when compared to the non-treated control. The decrease in the number of eggs/g soil and number of eggs/cyst in the control plots at the end of the second season indicated the presence of antagonistic organisms which naturally suppressed the cyst nematode population. Both solarization and fumigation apparently reduced the suppressive effect which resulted in the increase of the cyst nematode population.

DUFFUS, J.E. Diseases vectored by whiteflies: etiology, ecology, geographical distribution and possible control measures. Arab J. Plant Protection 12:143-148. 1994.

The whitefly-transmitted viruses produce a wide and divergent group of diseases, most of which have not been characterized. The agents are transmitted by at least three whitefly species in the nonpersistent, semipersistent, persistent and by biological mechanisms. The viruses cause significant losses throughout the world and are responsible for some 70 important diseases in the tropical and sub-tropical areas. Recent years have shown an increase in losses in wide areas north and south of the tropics, approaching areas of intensive agricultural production. The whitefly-transmitted diseases have been characterized in general on the basis of their transmission by whiteflies and the activity of the agents on host plants, such as symptoms and host range. A compilation of available data on the viruses themselves would suggest at least seven groups of viruses differing in type of virus particle, symptom type, and vector relationships. The two major groups of whitefly-transmitted viruses of worldwide importance (the geminiviruses and clostero- viruses) are differently transmitted by biotypes of *Bemisia*. This vector specificity impacts virus distribution and epidemiology. Transmission systems may be valuable to trace origins of viruses and their vectors.

DUFFUS, J.E. Whitefly transmitted yellowing viruses of the Cucurbitaceae. In: Cucurbitaceae '94:12-16. Lester & Dunlap (eds.), Gateway Printing. 1995.

Whitefly-transmitted yellowing viruses of cucurbits are causing severe economic losses throughout the world. Three distinct whitefly transmitted cucurbit viruses have been distinguished--beet pseudo yellows (BPYV), lettuce infectious yellows (LIYV), and cucurbit yellow stunting disorder virus (CYSDV). BPYV virus has caused severe losses in greenhouse grown cucurbit crops throughout North America, Europe, and Asia. It has been reported from France, The Netherlands, Japan, Italy, Spain, England, Australia, and Bulgaria. Since 1982, the incidence in melon crops under protected environments and outdoors on the Mediterranean coast of Spain has continually increased inducing considerable economic losses. The virus has a wide host range of important crop, weed and ornamental hosts. BPYV is transmitted by *Trialeurodes vaporariorum* in a semi-persistent manner and is retained by the insect for 6 days. Purified preparations contained long, flexuous particles 1500 nm long. The virus has been termed cucumber yellows, muskmelon yellows, melon yellows, and cucumber chlorotic spot virus, but these isolates have not been shown to be distinct from BPYV. A distinct whitefly transmitted virus, LIYV, was reported from the desert regions of California and Arizona in 1981. The virus, transmitted specifically by the A biotype of *Bemisia tabaci*, has a wide host range of important crop hosts. LIYV has long, filamentous particles 1800 nm long which are retained by *Bemisia* for 3 days. The virus has been also found in Texas and Mexico. In the early 1980's a yellowing and stunting disorder of cucurbits was noticed in the Middle East. The disease has been found in Jordan, Israel, United Arab Emirates, and Turkey. The virus, CYSDV, has a narrow host range, mainly in the Cucurbitaceae. CYSDV is transmitted specifically by the B biotype of *B. tabaci* and is retained by the vector for 10 days. Purified preparations contained long, flexuous particles 1200 nm long.

DUFFUS, J.E. Whitefly vectors of geminiviruses and closteroviruses. Proc. Third International Caribbean Conference of Entomology, Costa Rica, pg. 4. 1995.

Whitefly-transmitted viruses induce serious disease problems in vegetable and fiber crops worldwide. Recent changes in importance and world distribution of *Bemisia* and *Trialeurodes* are related to movement and displacement of biotypes or species. Biological and ecological information related to whiteflies and the disease they transmit are largely neglected in favor of chemical and biological control research on the whitefly and molecular biology of the viruses. Basic insect vector biology and host studies have to be developed in the areas of virus occurrence.

DUFFUS, J.E. Whitefly-borne viruses. In: *Bemisia* 1995: Taxonomy, biology, damage, control and management. Intercept, Ltd., Publishers, U.K. (in press). 1995.

The whitefly-transmitted viruses induce a wide and divergent group of diseases, most of which have not been characterized. The agents are transmitted by at least three whitefly species in the nonpersistent, semipersistent and persistent manner, and by biological mechanisms. The viruses cause significant losses throughout the world and are responsible for some 70 important diseases in the tropical and subtropical areas. Recent years have brought an increase in losses in wide areas north and south of the tropics, approaching areas of intensive agricultural production such as the southern United States and the Mediterranean region.

The whitefly-transmitted diseases have been characterized in general on the basis of their transmission by whiteflies and the activity of the agents on host

plants, such as symptoms and host range. A compilation of available data on the viruses themselves would suggest at least seven groups of viruses differing in type of virus particle, symptom type, and vector relationships. These include geminiviruses, and viruses similar to the clostero- viruses, carlaviruses, potyviruses, nepoviruses, luteoviruses and a DNA-containing rod-shaped virus.

Recent changes in importance and world distribution of *Bemisia* seem to be related to movement and displacement of biotypes or species. These movements of insects with different host and vector affinities have significantly altered epidemiological characteristics of some whitefly-transmitted viruses.

The demonstration of vector specificity between biotypes implies that similar vector specificity may occur in other areas of the world and that virus distribution may be dependent on the geographical distribution of the whitefly biotypes. Transmission systems may be a convenient tool to trace the origins of viruses and their vectors.

DUFFUS, J.E. Whitefly-transmitted tomato infectious chlorosis virus: etiology and epidemiology. Proc. 8th Conference of ISHS Working Group on Vegetable Viruses, Prague, pg. 39. 1995.

A new virus of tomato and other crop and weed hosts was found in California. Tomato plants affected by the virus exhibited interveinal yellowing, necrosis and severe yield losses. The virus, tomato infectious chlorosis virus (TICV), is transmitted in a semi-persistent manner by the greenhouse whitefly, *Trialeurodes vaporariorum*. The host range of the virus includes 26 species in 8 plant families including tomato (*Lycopersicon esculentum*), potato (*Solanum tuberosum*), tomatillo (*Physalis ixocarpa*), artichoke (*Cynara scolymus*), lettuce (*Lactuca sativa*), petunia (*Petunia hybrida*) and Zinnia (*Zinnia elegans*). Purified virus preparations contained long, filamentous particles 12 x 850-900nm. The virus is not mechanically transmitted or transmitted by *Bemisia*. ELISA tests demonstrated that antisera against TICV reacted with purified TICV and reacted to TICV-infected tissue from tomato, potato, *N. clevelandii*, *N. benthamiana*, and *D. wrightii*, but not with healthy plants of the same species. The antisera did not react with plant species infected with other whitefly-transmitted viruses, beet pseudo yellows, lettuce infectious yellows, or cucurbit yellow stunting disorder. The virus has been found in a number of different locations in California and has a number of potential vehicles of movement including greenhouse grown ornamentals, tomato transplants, artichoke cuttings and potato tubers. The virus has the potential to spread to other growing regions with resident populations of the greenhouse whitefly.

DUFFUS, J.E., H.-Y. LIU, and G.C. Wisler. Tomato infectious chlorosis virus--A new clostero-like virus transmitted by *Trialeurodes vaporariorum*. Eur. J. Pl. Path. (in press). 1995.

A previously undescribed virus disease of tomato, other crop and weed hosts was found in California. Affected tomato plants exhibited interveinal yellowing, necrosis and severe yield losses. Leaf dips and purified preparations contained closterovirus-like long flexuous, filamentous particles approximately 12 x 850-900 nm. The virus, designated as tomato infectious chlorosis virus (TICV), is transmitted in a semipersistent manner by the greenhouse whitefly, *Trialeurodes vaporariorum*. The host range of the virus is moderate (26 species in 8 plant families) but includes some important crops and ornamental species including tomato, (*Lycopersicon esculentum*), tomatillo (*Physalis ixocarpa*), potato (*Solanum tuberosum*), artichoke (*Cynara scolymus*), lettuce (*Lactuca sativa*) and petunia (*Petunia hybrida*). The virus has been found in a number of different locations in California and has a number of potential vehicles of movement including greenhouse grown ornamentals, tomato transplants, artichoke cuttings and potato

seed. The virus has the potential to spread to other growing regions with resident populations of the greenhouse whitefly. The host range, particle size, insect transmission, and serology clearly distinguish TICV from previously described viruses.

HARRIS, K.F., Z. PESIC-VAN ESBROECK and J.E. DUFFUS. Moderate-temperature polymerization of LR white in a nitrogen atmosphere. Microscopy Research and Technique 32:264-265. 1995.

We have processed whole-insect specimens on more than a dozen occasions since adopting this oxygen-free polymerization protocol. To date, all blocks obtained have had excellent trimming and sectioning characteristics. Serial sectioning of whole insects is now not only possible but routine.

Antigenicity is preserved by lowering the polymerization temperature to 55°C. Virus particles have been localized both in the vector and virus-infected plants using immunogold-silver staining followed by light and electron microscopy.

While establishing the present protocol, many abbreviated versions were tested. That testing led us to conclude that each and every step of the protocol ("infusing" the liquid resin with N₂, evacuating or degassing the N₂-infused resin, covering the mold with Aclar™, and polymerizing the resin in a nitrogen atmosphere) is essential to consistently obtaining high quality embeddings at a polymerization temperature of 55°C.

HARRIS, K.F., Z. PESIC-VAN ESBROECK and J.E. DUFFUS. Nitrogen as an infusion and polymerization medium for LR white embedding of whole small insects. Phytopathology 85:1180. 1995.

Oxygen-free embedding of whole whitefly virus vectors in LR White at moderate temperature preserves viral antigenicity while yielding high-quality specimens which can be serially sectioned for light and electron microscopy and immunocytochemistry. The protocol includes "infusing" the liquid resin with N₂, evacuating the N₂-infused resin, covering embeddings with film, and polymerizing in a nitrogen atmosphere. The technique ought to be equally adaptable to studying plant viruses in whole specimens of other arthropod vectors such as aphids, leafhoppers, planthoppers, thrips and mites.

HARRIS, K.F., Z. PESIC-VAN ESBROECK and J.E. DUFFUS. Vector anatomy of the sweet potato whitefly. Proc. 8th Conference of ISHS Working Group on Vegetable Viruses, Prague, pgs. 49-52. 1995.

The comparative morphologies of several organ systems of *Bemisia tabaci* (Gennadius), the sweet potato whitefly (SPW), were studied by light microscopy. Similarities among whitefly, aphid and leafhopper feeding apparatuses suggest that whiteflies too are capable of ingestion-egestion behavior and that noncirculative whitefly-transmitted viruses are "cuticula-borne."

The basic plan of the salivary system of the SPW is similar to that of aphids. Morphological data on the salivary and digestive systems of the SPW, combined with data from both light and electron immunomicroscopy of the fate of squash leaf curl virus (SLCV) in the vector, suggest some unique SPW-geminivirus interactions.

LEWELLEN, R.T. Registration of sugarbeet germplasm lines with multiple disease resistance: C39, C39R, C39R-6, C47, C47R, C93, and C94. Crop Sci. 35: 596-597. 1995.

C39 was released in 1986. It was derived from a broadly based composite cross made in 1973. C39 was advanced and evaluated as breeding line Y39. Ten cycles of recurrent phenotypic selection have been completed for multiple disease resistance, agronomic traits, and productivity. During each cycle of selection, sugar concentration and yield and root conformation of individual plants grown under infected conditions were used as the primary selection criteria. C39 has relatively high sucrose concentration and yield, particularly when tested under virus yellows conditions. It is moderately resistant to virus yellows, Erwinia root rot, and bolting. It has higher powdery mildew resistance than any other line developed at Salinas. It is moderately susceptible to curly top virus. C39 is an advanced, broadly based germplasm line and should be a valuable source of combined disease resistance. It may have potential as a source for extracting disease-resistant pollinator lines.

C39R was released in 1988. After Y39 was identified as having variability for tolerance to rhizomania, it was entered into the rhizomania resistance breeding program. It was then advanced and tested as breeding line R39. Starting with the fifth-cycle synthetic of Y39 that led to C39, five additional cycles of recurrent phenotype selection were made for resistance to rhizomania. In hybrid combinations with rhizomania susceptible lines, the expression of resistance is intermediate and appears to be due to quantitatively inherited additive factors. This type of quantitative resistance appears to augment the partial resistance provided by the Rz major gene, giving an increased level of protection. In comparison with C39, C39R has lower sugar concentration and higher root yield, probably because root size was as used as a criterion of selection. C39R should be a source of combined disease resistance in a productive base for further breeding and for extraction of potential pollinator lines for hybrids.

C39R-6 was released in 1988. It is an increase of one full-sib family from the second cycle of selection that ultimately produced C39R. Pair crosses were produced among 18 roots that had been selected for resistance based on root symptoms of 4-mo-old roots and negative ELISA values for BNYVV. Two additional cycles of recurrent phenotypic selection were made for resistance to rhizomania within these families. In field tests, the family tested as R39-6 showed the best combination of traits for resistance to rhizomania, sugar yield, and non-bolting tendency. In experimental hybrids tested under rhizomania conditions, C39R-6 showed potential as a pollinator to produce moderately rhizomania resistant hybrids.

C47 was released in 1989. It was derived from composite crosses made in 1979 of green hypocotyl plants of C36 and C37 open-pollinated with red hypocotyl plants of C01, C31, C46, and C91 type germplasm lines. Seed was harvested only from C36 and C37, and F₁ plants were identified by the red hypocotyl marker. After two cycles of recombination, six cycles of recurrent phenotypic selection were made. Experimental hybrids have had good performance, with the best relative performance in the Imperial Valley of California. C47 should be useful as a source of combined disease resistance and for extracting potential pollinator lines.

C47R was released in 1989. It was derived from the first-cycle synthetic of Y47. Y47 showed low levels of variability for tolerance to rhizomania under infested field evaluation. Five cycles of recurrent phenotypic selection have been made in a program identical to the development of C39R. C47R was identified as R47 during its development. C47R appears to have quantitative resistance to rhizomania nearly equal to that of C39R.

C93 was released in 1989. It was developed from crosses made in 1979 among green hypocotyl plants of C36 and C37 with red hypocotyl plants of Y23 and Y26. The developmental history is nearly identical to that of C47. Y23, subsequently released as C15, was the third-cycle synthetic selected for virus yellows resistance from the obsolete multigerm open-pollinated variety US15. Y26 was the

third-cycle synthetic selected for virus yellows resistance from the obsolete multigerm open-pollinated variety US 56/2. C93 was developed as breeding line Y48. C93 may be useful as a source population with a somewhat different genetic base and higher sucrose concentration potential than other releases from Salinas.

C94 was released in 1989. After recognition of the importance of rhizomania in California, a large number of germplasm lines from many sources were screened for resistance under field conditions at Salinas. Most highly bred sugarbeet germplasm was found to be highly susceptible, except for the sources of C39R and C47R. An exception was a low frequency of plants within germplasm lines originating from the Great Western and USDA breeding programs in Colorado. Plants from within lines FC 703, FC 705, FC 709, GW 674, GW 359, GW 777, and GW 602 that appeared partially resistant were selected and crossed in pairs. The full-sib families were evaluated for reaction to rhizomania, and individual plants from within 14 of the most resistant families were selected and recombined into a single population, which was assigned the breeding line number R20. The resistance to rhizomania in C94 appears to be quantitatively inherited and conditions a lower level of resistance than C39R. C94 has very low sucrose concentration and high root yield characteristics. It appears to have disease reactions and bolting susceptibility as expected for its germplasm base. In tests in Colorado, C94 showed moderate resistance to root rot caused by *Rhizoctonia solani* Kühn (anastomosis group AG-2-2).

LEWELLEN, R.T. Registration of three cyst nematode resistant sugarbeet germplasms: C603, C603-1, and C604. Crop Sci. 35: 1229-1230. 1995.

These lines are diploid ($2x = 18$), multigerm, and self-fertile (S^f). They are homozygous resistant to sugarbeet cyst nematode *Heterodera schachtii* Schmidt). The source of resistance was line B883 from the Netherlands. Line B883 was derived from an alien addition line ($2n = 19$) with *Beta procumbens* Chr.Sm. chromosome-1 developed at Salinas and released about 1972. C603, C603-1, and C604 were released in 1993 as a source of nematode-resistant germplasm for use in nematode research studies and breeding programs.

These lines have the same general root and canopy architecture as B883. They are low in vigor and produce multiple, short seed stalks with multigerm seed balls of four or more true seeds each. Rosette leaves and leaves on seed stalks rapidly yellow and senesce early. Pollen production is only fair and tends to clump following delayed dehiscence.

The roots, crowns, and to some extent the aerial parts of the shoot have a tendency to produce galls or tumors. Abnormal leaf development from crown buds and galls is not unusual. The plants are biennial, but would be classified as easy bolting in overwintered bolting evaluations. Nonetheless, seed stalk development, flowering, and pollen production from stecklings are very retarded, and matches for crossing to nematode-susceptible plants are difficult. Nematode resistance transmission is high from these homozygous lines, but heterozygous progeny from crosses and advanced backcross generations have low transmission rates. New homozygous resistant types are rare. Tracking the nematode-resistant segregates is aided by the apparent close linkage between the factors for nematode resistance and root galling. In ongoing work, even in the absence of nematode infestations, this high association between these traits has allowed the backcross breeding procedures to continue. In some backcross families descended from C603, a very low frequency of galled plants with high nematode infestations have been found. This suggests that the linkage may not be absolute. From heterozygous nematode-resistant plants, transmission of resistance appears to be much higher through the egg than through pollen.

C603 was produced from bulked increases from one homozygous resistant S_2 line that had been randomly generated from a cross between an improved line from C17

and B883. It has mixed red and green hypocotyls. The plants in C603 have a very small canopy and small, conical tap roots with very low sucrose concentration. C603 is moderately susceptible to diseases that are prevalent in the far west of the USA. Hybrids with C603 are uniformly cyst nematode resistant and retain a smaller canopy than most hybrids with the same female components. The root yield of the experimental hybrids is similar to commercial hybrids but the sucrose concentration is 2 to 4 percentage points lower. After 3 to 4 mo. of age, the hybrid plants have a tendency to form root galls and leaves are retained for a shorter duration, sometimes being replaced by leaves with very short petioles and small blades. C603 was developed and evaluated under experimental line designations N103, N203, and N303.

C603-1 was increased from one S₃ plant within C603 that was slightly more vigorous and had better pollen production and seed yield. C603-1 is homozygous for green hypocotyl color. Otherwise, C603-1 is nearly identical to C603. C603-1 was developed and evaluated under experimental line designations N103-1, N203-1, and N303-1. C603-1 and C603 were combined into a single pollinator line to produce experimental topcross hybrids for evaluating performance and disease resistance characteristics.

C604 was identified as a homozygous nematode-resistant S₂ line. The S₂ had been randomly generated from a cross between population 909 and B883. C604 is homozygous for red hypocotyl color. Like C603 and C603-1, it has been found to be homozygous nematode resistant to a diversity of *H.schachtii* physiological races. Under some field and seed production conditions, C604 is highly susceptible to an unidentified root rot. Hybrids with C604 have not been made and its agronomic performance and combining ability characteristics are undetermined. C604 was developed under experimental line designations N204 and N304.

LIU, H.Y., G.C. WISLER and J.E. DUFFUS. Partial characterization and molecular cloning of tomato infectious chlorosis virus (TICV). *Phytopathology* 85:1184. 1995.

A new yellowing disease of tomato was found in California in 1993. The inciting clostero-like virus, TICV, was transmitted by the greenhouse whitefly (*Trialeurodes vaporariorum*) in a semipersistent manner, but was not mechanically transmissible. Flexuous filamentous particles with a modal length of 850-900 nm were consistently observed in leaf dip preparations of TICV-infected plants. Complementary DNA synthesis and cloning used the virion RNA (ca. 8.0 kb) isolated from TICV-infected *Nicotiana clevelandii* as a template. These clones specifically reacted with purified TICV-RNA, dsRNA, as well as with RNA extracted from TICV-infected plants in dot blot analyses. No reactions were observed in dot blots against other whitefly transmitted closteroviruses including beet pseudo yellows, lettuce infectious yellows, lettuce chlorosis, or cucurbit yellow stunting disorder.

PESIC-VAN ESBROECK, Z., K.F. HARRIS and J.E. DUFFUS. Bemisia-geminivirus immunocytochemistry. Proc. 8th Conference of ISHS Working Group on Vegetable Viruses, Prague, pgs. 89-92. 1995.

Squash leaf curl virus (SLCV), a circulative whitefly-borne geminivirus, was localized in squash (*Cucurbita* sp. L.) and its vector the sweet potato whitefly (SPW), *Bemisia tabaci* (Gennadius) by immunogold cytochemistry. Light microscopy of immunogold silver-stained (IGSS-LM) semi-thin squash leaf sections and transmission electron microscopy of immunogold-labeled (IGL-TEM) viral antigen in ultrathin sections showed that SLCV is phloem-restricted. Fibrillar rings were observed in the nuclei of infected phloem parenchyma cells.

In viruliferous whiteflies, SLCV invades numerous organs and tissues in its passage from the maxillary food canal in the feeding apparatus (acquisition) to the ducts of the salivary system (inoculation). SLCV was localized by immunogold labeling in the digestive, excretory, reproductive and salivary systems and the hemocoel, mycetome and fat body. The observation of gold label and virus particles around and in nuclei of several organs, as well as cytopathological changes in organs of the digestive, reproductive and excretory systems suggest that SLCV may multiply in its vector *B. tabaci*.

PESIC-VAN ESBROECK, Z., K.F. HARRIS and J.E. DUFFUS. Immunocytochemical localization of squash leaf curl virus (SLCV) in squash and the sweet potato whitefly. Phytopathology 85:1180. 1995.

Studies were conducted to localize SLCV, a circulative whitefly-borne geminivirus, in squash (*Cucurbita* sp.) and its vector *Bemisia tabaci* (Genn.) using light and transmission electron microscopic (TEM) immunolabeling procedures. Light microscopic examination of immunogold-silver stained squash

leaf sections showed that SLCV is phloem-restricted. the latter was confirmed by TEM and immunogold labeling of virions in ultrathin leaf sections. Fibrillar rings, characteristic of geminiviruses, were observed in the nuclei of infected phloem parenchyma cells. Immunogold-TEM of viruliferous whiteflies indicates unique interactions between SLCV and *Bemisia*'s digestive and salivary systems.

PESIC-VAN ESBROECK, Z., K.F. HARRIS and J.E. DUFFUS. Morphology of the whitefly feeding apparatus relative to noncirculative plant virus transmission. Phytopathology 85:1180. 1995.

The comparative morphology of *Bemisia*'s feeding apparatus was studied by light microscopy and analyzed relative to known noncirculative virus-vector interactions. Similarities among whitefly, aphid and leafhopper feeding apparatuses suggest that whiteflies too are capable of ingestion-egestion behavior and that noncirculative whitefly-transmitted viruses are cuticula-borne: carried at specific sites on the cuticula lining the lumina of the maxillary food canal and cibarium (antecibarium, cibarial valve and postcibarium) of the feeding apparatus. It appears that virus carried at sites beyond the feeding apparatus in the pharynx of the foregut of homopteran vectors would not be available for inoculation by egestion.

WISLER, G.C., H.Y. LIU and J.E. DUFFUS. Partial molecular characterization of several furoviruses of sugar beet from the U.S.A. Phytopathology 85:1146. 1995.

Two beet necrotic yellow vein virus (BNYVV) isolates (CA, ID) and four isolates (two each from TX and NE) that are serologically related to beet soil-borne mosaic virus (BSBMV) were compared for size, polyadenylation, cross-hybridization and number of RNA components. RNA-1, -2, and -3 of the two BNYVV isolates were the expected sizes of ca. 6.6, 4.7, and 1.8 kb, respectively. The RNA-1 and -2 from BSBMV of TX were similar to those of BNYVV, but RNA-3 was smaller, at ca. 1.4 kb. An isolate serologically related to BSBMV from NE had RNA-1, -2, and -3 identical in size to BNYVV, but had an additional RNA-4 of ca. 0.9 kb. A new isolate from NE, serologically identical to BSBMV but with a host range wider than that of other sugar beet furoviruses, had an RNA pattern identical to BNYVV. Probes from RNA-1 and -2 of BNYVV were specific to the BNYVV isolates. All RNAs of all isolates examined were polyadenylated, thus are more like BNYVV than the type member of the furovirus group soil-borne wheat mosaic virus.

YU, M.H. Biological Methods of Nematode Control in Sugarbeet. Toward enhanced and sustainable agricultural productivity in the 2000's: breeding research and biotechnology. SABRAO, Taipei, Taiwan. pp. 913-919. 1994.

Sugarbeet, *Beta vulgaris* L., is an excellent host for numerous species of nematode. Cyst nematode (*Heterodera schachtii* Schm.) and root-knot nematode (*Meloidogyne* spp.) are economically important plant pathogens which are difficult to control. Cyst nematode is widely distributed in sugarbeet growing regions whereas the root-knot nematode occurs in warmer areas and has a wider host range. Control of sugarbeet nematode is influenced by the nematode population density, planting time, microbial interactions, nematicide use, cropping system, and host genotypes. Crop rotation combined with cultivation practices have been successfully used to control the cyst nematode. Several trap crops are available for intermediate cropping in crop rotations. Nematode parasitic bacteria, fungi, and other microorganisms are being identified and developed. Breeding of sugarbeet resistant to the cyst nematode via interspecific hybridization has been conducted with positive results. Sugarbeet breeding for resistance to the root-knot nematode has recently begun. Development of resistant varieties will compensate for sugarbeet crop losses caused by the restricted use of chemicals.

YU, M.H. Identification of a *Beta maritima* Source of resistance to Root-Knot Nematode for Sugarbeet. Crop Sci. 35:1288-1290. 1995.

Root-knot nematodes (*Meloidogyne* spp.) are economically important plant pests that cause root gall symptoms and limit sugarbeet (*Beta vulgaris* L.) production. With the increasingly restrictive use of nematicides, the development of resistant sugarbeet cultivars becomes urgent. This study was conducted to identify the source of root-knot nematode resistance and to evaluate transmission of resistance in sugarbeet hybrid progeny. One hundred-ninety *B. vulgaris* and 113 sea beet (*B. maritima* L.) germplasm lines and accessions were evaluated for nematode resistance, via inoculations, under greenhouse and growth chamber conditions. Beet seedlings developed better root systems in containers and pulp pots than in growth pouches for host reaction to the nematode infection assay. From non-cultivated sea beet, an accession (PI 546387) was identified that segregated for plants free from root gall formation and from reproduction of *M. incognita* Race 1. resistance was transmitted to approximately 23% of the F₁ progeny when resistant *B. maritima* phenotypes were crossed to sugarbeet. Development of sugarbeet root-knot nematode resistant cultivars should be facilitated by this identification of a resistance source and the close phylogenetic relationship of the two *Beta* taxa.

YU, M.H. Root-Knot Nematode Development and Root Gall Formation in Sugarbeet. J. Sugarbeet Research 32:47-58. 1995.

Development of *Meloidogyne incognita* and formation of root galls on greenhouse-grown sugarbeet (*Beta vulgaris* L.) seedlings grown in sand was examined at 4-day intervals over a period of 40 days. The penetration and development of root-knot nematode on sugarbeet was asynchronous and multiform. The majority of second-stage juveniles (J2) entered the roots through the root tip region, including the root cap. Before growth began, body length and width of the invading J2 decreased about 10%. Infected root segments initiated galls within 4 days and galls became stainable within 6 days after infection. The males usually developed in groups. Body length of the vermiform adult males was approximately 5 times that of the J2. Mean size (length x width) of adult males was 1.0 x 0.05mm and of females was 0.8 x 0.5mm. Diameter of the females increased 16-30 fold between 8 and 40 days after infection of roots. In the same period, diameter of root galls increased 3 fold when plants were grown in sand; the size of root galls responded to the level of nutrients.

YU, M.H. Root-Knot Nematode Infection And Host Plant Reaction In Beets. J. Nematol. 26:570-571. 1994.

Sugarbeet (*Beta vulgaris* L.) germplasm lines and sea beet (*B.maritima* L.) accessions were evaluated in greenhouse tests for resistance to root-knot nematode, *Meloidogyne incognita*. Individual seedlings were grown in containers, inoculated during the 4- to 6-leaf stage with 1,000 second-stage juveniles per plant, and examined 35 days after inoculation. The level of nematode reproduction, i.e., eggs and larvae, was positively associated with root gall formation. Although all sugarbeet genotypes investigated were susceptible to root-knot nematode, a few plants from over 100 accessions of *B. maritima* were resistant. The nematode resistance derived from sea beet is heritable, and is a valuable source of root-knot nematode resistance for sugarbeet.

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YU, M.H. Sugarbeet root-knot nematode and approaches taken to develop resistant varieties. J. Sugar Beet Research 32:166. 1995.

DEVELOPMENT OF SUGARBEET BREEDING LINES AND GERMPLASM

R.T. LEWELLEN

C78/2, C76-43-14, C76-43-15, C76-89-5 and C76-89-18 - These lines were distributed in 1995 from the Salinas breeding program. Officially they will be released in 1996 after seed is accepted by the National Seed Storage Laboratory (NSSL) and a PI number assigned.

C78/2, C76-43-14, C76-43-15, C76-89-5, and C76-89-18 are multigerm, self-sterile breeding lines that segregate for hypocotyl color. All except C76-89 have resistance to rhizomania (Rz), caused by beet necrotic yellow vein virus (BNYVV). All were derived from base populations developed in the virus yellows and multiple disease resistance program at Salinas.

C78/2 has a C46/2 background and will be similar to C78 released in 1994, but could have a higher level of combined resistance to diseases and bolting. Compared to C78, C78/2 has one additional cycle of selection for resistance to rhizomania before being selected for nonbolting tendency. The reselection for high sucrose content should have helped identify plants with multiple disease resistance including resistance to rhizomania. C78/2 is being evaluated as breeding line R578/2.

C76-43-14, C76-43-15, C76-89-5, and C76-89-18 are increases and reselections within full-sib families that appeared to have individual merit for sugar yield combining ability and combined resistance to disease and bolting. C76-43-14 and C76-43-15 were reselections within two of the eight progeny lines that were composited to produce C76-43. C76-89-5 and C76-89-15 were reselections within two of the six component progeny lines that produced C76-89. Based upon per se and testcross hybrid evaluation, these lines have traits similar to C76-43, C76-89, and C82. In general, these four lines are moderately susceptible to curly top virus, intermediate for reaction to powdery mildew and virus yellows, moderately resistant to bolting and *Erwinia* root rot, and, except for C76-89-18, segregate for resistance to rhizomania. More specifically, C76-89-18 has high sugar yield performance per se and in hybrids when evaluated under virus yellows (beet yellows and beet western yellows viruses) conditions. C76-89-5 has significantly higher sucrose concentration but lower sugar yield than the other three lines in this group. C76-43-14 has the highest sugar yield overall. C76-43-15 has high resistance to bolting, *Erwinia*, and powdery mildew. One or more of these lines may be useful as a source from which to develop parental lines with combined resistance to rhizomania, bolting, *Erwinia* root rot, virus yellows, and/or powdery mildew in a high yielding background. These lines have been tested as R76-43-14, R76-43-15, R76-89-5, and R76-89-18. It now appears that C76-89-18 does not possess the Rz factor for resistance to rhizomania.

C890-1 through C890-10/11 - These lines were distributed in 1995 from the Salinas breeding program. Officially they will be released in 1996 after being submitted to the NSSL and being assigned PI numbers.

C890-1 through C890-11 are lines in a C790 background with resistance to rhizomania, caused by beet necrotic yellow vein virus. Each line in the C890 series involved a different initial source that was known or had been identified as having resistance to rhizomania. C790 was chosen as the recurrent parent because of its adaptation to the western USA. Extractions from C790 populations have been used as parental lines in proprietary

commercial hybrids. C790 is an increase of the fifth cycle synthetic of population 790 that was developed by five cycles of S_1 progeny recurrent selection for sugar yield. In addition to good sugar yield combining ability, it has good O-type and monogerm seed characteristics. C790 is self-fertile and segregates for genetic male sterility. It is uniformly susceptible to rhizomania.

Lines in the C890 series will segregate for monogermity and resistance to rhizomania. Because rhizomania resistance could be traced through the backcrossing procedure, it is thought that resistance is dominant and usually monogenic. If this is so, and no escapes were selected in the 1994 cycle of selection, then the gene frequency for resistance in these F_2 lines will be about 0.5 and 75 percent of the individual plants will be resistant.

Usually rhizomania susceptible, monogerm, genetic male sterile (aa) plants of C790 were used as the female parent, although in some initial crosses, pollen fertile plants of C790 were crossed onto the self-sterile sources of resistance. Also, in some instances, fertile C790 plants were crossed onto genetic male sterile segregates from the previous backcross. Crosses were made under paper bags as pair plant crosses in the greenhouse.

Seed produced on C790 was harvested separately and composited. Usually 6 to 12 crosses were made per source per backcross. F_1 's were identified by resistance to rhizomania. Selections for resistance were made in 4 month old plants grown in uniformly BNYVV infested field plots. Plots were usually sown in early August after seed had been produced and processed in the early summer. Resistant plants were selected in the field in early December based upon absence of root symptoms, root size and shape, and freedom from bolting. Under these conditions, escapes occur and may have been selected.

The table lists the number of crosses and backcrosses to C790 and other sugarbeet lines. It also briefly describes the sources of resistance to rhizomania. These sources include sugarbeet, Swiss chard, weed beet, and *Beta maritima*. This series of lines is being released as potentially new sources of resistance to rhizomania. The allelism or relationship among these sources has not been determined. In 1994, these same sources of resistance were released in a C37 background. If some of these sources of resistance are found to be unique or useful, the C890-1 to C890-11 series may permit the fairly rapid development of these sources in monogerm, O-type lines. As presently released, the C890-1 through C890-11 F_2 lines will segregate for most production and agronomic traits including monogermity, O-type, genetic male sterility, self-fertility, annualism, and hypocotyl color.

Release No.	1995 Seed No. ¹	Crosses to C790 ²	Crosses to SB ³	Source of Resistance ⁴
C890-1 ⁵	5890	2	SB	Holly, Rz
C890-2/3	5812	2	4	WB41/42, C48
C890-4	5814	2	7	PI206407, C28
C890-5	5815	2	4	Weed beet, R04
C890-6/7	5817	1	SB	R05/Rima (SES)
C890-8	5818	2	4	<i>B.maritima</i> , C50
C890-9	5819	2	6	WB151
C890-10/11	5820	1	5	WB169/258

¹Seed lots produced and distributed in 1995. All of these lots are bulk increases of BC_nF₁ plants and will be mixtures of S₀ (F₂) and S₁ individuals.

²Number of crosses to monogerm plants from population C790.

³SB = sugarbeet. Total number of crosses and backcrosses to all sugarbeet lines.

⁴Line or source in which resistance originated. Rz is from a Holly hybrid. WB41, WB42, and WB151 are *B.maritima* accessions from Denmark probably collected by Viggo Lund about 1950. WB169 is *B.m.* accession from Italy collected by Dr. G. Coons in 1971. WB258 is *B.m.* accession from Italy collected by Dr. DeBiaggi in 1979. C50 is composite cross of about 60 *B.m.* accessions (Salinas collection) onto sugarbeet, also known as R22. Weedy beet accession from Italy was provided by E. Biancardi. R05 is a sugarbeet accession from Italy. PI206407 is listed as a sugarbeet accession from Turkey, but the only resistant plant had Swiss chard traits.

⁵C890-1 is a different version than released in 1993 as C890. C890-1 has one fewer backcrosses to C790 than C890. C890-1 is the recombination of monogerm S₁ lines produced under bags in the greenhouse. From 50 S₁ lines evaluated under rhizomania infested conditions in an overwintered planting, stecklings from 16 lines produced from remnant seed were selected on the basis of nonbolting and sucrose concentration and recombined through genetic male sterile segregates. C890-1CMS will be distributed along with C890-1.

C913-70, A PROPOSED RELEASE IN 1996 - C913-70 is a narrowly based, multigerm line. It may have potential as a parental line to produce hybrids where combined resistance to rhizomania, bolting, and *Erwinia* is desired. C913-70 was selected from population-913 on the basis of S₁ progeny, line, and test cross hybrid performance. It demonstrates one of the ways in which MM, S^f, Aa (multigerm, self-fertile, genetic male-sterile facilitated random-mated) populations can be used that have been under development at Salinas over the past 28 years.

C913-70 is a multigerm, self-fertile (S^f), green hypocotyl (rr) line that segregates for genetic male sterility (Aa). It is the third increase from the S₁ progeny line. The second and third increases were from mother roots selected for resistance to rhizomania, caused by BNYVV. The S₁ line was produced from an individually bagged mother root selected for resistance to rhizomania from population-913. Popn-913 is a multigerm, self-fertile, genetic male-sterile facilitated population similar to C918. The S₁ line was selected on the basis of performance and nonbolting in an S₁ progeny test. Experimental hybrids were produced in conjunction with each seed increase. The line and experimental hybrids were evaluated in replicated field trials at Salinas, Brawley, and Davis, CA. On the basis of these tests, C913-70 was selected from a set of sister lines as having the best combination of yield and disease resistance.

Relative to similar material, C913-70 has good sucrose concentration and combining ability for sugar yield. It has high resistance to bolting in fall/winter plantings and to *Erwinia* in inoculated evaluations. C913-70 has the Rz allele for resistance to rhizomania. It was not determined whether this factor is homozygous or segregates. C913-70 is moderately resistant to powdery mildew and virus yellows. It retains a darker green canopy when BYV/BWYV infected than most lines. C913-70 is intermediate in reaction to curly top and moderately susceptible to rust. The reaction to other diseases and pests is unknown. C913-70 is uniform and has moderate vigor. Its leaves are flat with smooth margins. The potential genetic variability in C913-70 is limited to that from a line descended from a single diploid plant within a random-mated population. Further improvements may be possible.

C913-70 should be tested for its potential as a parental line to produce combined disease and bolting resistant hybrids. Although not tested in the San Joaquin Valley, the hybrids of C913-70 should meet the requirements for the spring and fall planted, overwintered areas where there is severe pressure from rhizomania, *Erwinia*, and bolting and where moderate levels of curly top and virus yellows resistance are desirable. If C913-70 segregates for *Rz* then progeny testing may be needed to fix resistance to rhizomania. Because C913-70 segregates for genetic male sterility, it could potentially be used as the C-parent to produce double-cross hybrids when there would be an advantage to combine different sources of resistance and factors for productivity. It may also be useful as a germplasm line to generate new breeding material.

C913-70 was tested as line 4913-70 and hybrid 4913-70H50 = C790-15CMS x 3913-70 in 1995. In this Report, for bolting, see tests 195 & 695; for yield, tests 2095 (nondiseased), 4795 (moderate rhizomania), & 1995-1 Davis (virus yellows); and Kimberly CT test. In the 1994 Report, for bolting, see tests 194, 294-2, & 794; for *Erwinia* & powdery mildew, 2694; and for performance, 1494 (nondiseased), 1994 & Davis 1994-3 (virus yellows), 4094 (rhizomania), and B794-2 for yield under rhizomania at Brawley. In 1994, C913-70 was tested as 3913-70 and 3913-70H20 = (C562CMS x C309) x 1913-70. The original *S*₁ progeny test of C913-70 as line 1913-70 was in test 792 (see p. A115, 1992 Report).

An annotated pedigree of C913-70 is as follows:

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C913-70 = 1996 seed lot 6913-70
1996      6913-70 = RZM 5913-70 (RZM = mass sel. for resistance to rhizomania)
1995      5913-70 = RZM 3913-70
1993      3913-70 = Inc. 1913-70 (stecklings of S1 line selected on
                                basis of S1 progeny test in 1992)
1991      1913-70 = RZM 0913* (selfed in greenhouse by bagging of
                                pollen fertile mother root #70)
1990      0913 = RZM 9911H49aa x 9911,9911H49 (aa x A-, therefore,
                                all S0 plants would be Aa or aa)
1989      9911 = RZM 8911 (popn-911)
1989      911H49 = 7903aa x 8911
1988      8911 = RZM 7239
1987      7239 = 6903aa x RZM 6237
1986      6237 = 5903aa x R501H5
1985      R501H5 = 4747aa x RZM 82C30-08
                                82C30-08 = Experimental Holly CMS
                                hybrid produced in 1982 from
                                14G514-01 x C37 where 14G514-01 =
                                CMS of source line for resistance
                                to rhizomania, Rz, a psuedo-self-
                                fertile line developed by Dr. Arvin
                                Ericksen, Holly Sugar Company.
                                Partially fertile (restored) plants
                                of 82C30-08CMS were used as males
                                and crossed onto aa (genetic ms)
                                plants of 4747 in the greenhouse in
                                1985 to eliminate the CMS trait and
                                to transfer Rz to a MM,Sf,Aa breed-
                                ing line.

                                7903,6903, and 5903 = popn-903 = MM,Sf,Aa
                                population similar to C46 that was
                                under-going improvement for VYR, ER,
                                PMR,NB,etc.

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4747 = popn-747 = MM,S^f,Aa population similar to C37 that had been improved for VYR,ER, and NB and was an initial component of popn-903. Popn-747 was

from a population cross made in 1975 between C773aa x C17. C773 = popn-773 = MM,S^f,Aa population developed from crosses made in 1967 among [S₁(NB1aa x C13 & C234)]aa x MM,S^f lines from the VY resistance breeding program. NB1a = MM,S^f,Aa line. C13 = MM,S^sS^s, VYR line. C234 = MM,S^sS^s,VYR line from an accession from the Netherlands (Bergen op Zoom).

CR09 and CR10, PROPOSED RELEASES IN 1996 - *Cercospora* leaf

spot of sugarbeet occurs in California, particularly in the Northern Sacramento Valley and Tulare Basin area of the San Joaquin Valley. It also may occur wherever sprinkler irrigation is used. To be most useful, *Cercospora* resistance (CR) needs to be combined with resistances to rhizomania, bolting, curly top, virus yellows, Erwinia root rot, powdery mildew, and high productivity. In the late 1980's, a CR breeding program was initiated at Salinas, using CR lines from Rovigo, Italy. One of the small field plot areas (Field C) where tests for rhizomania resistance have been conducted since 1984 has developed *Cercospora beticola* by natural infection and has provided a field plot area where combined evaluation and selection for resistance to *Cercospora* and rhizomania can be conducted. As needed, supplementary artificial inoculation also has been used.

In 1995, all tests (6195 - 7295) in Field C were naturally infected with *Cercospora* and scored. Test 6495 was specifically designed and grown to evaluate the ongoing material for CR and to make CR-Rz selections. Based upon the results of test 6495 (also see 6395 in Ft. Collins report, and 7095), it appeared that CR and Rz had been successfully combined. The CR of R409 and R410 were equal to their Italian sources, R105 and R106, respectively. From R409 and R410, the roots with the highest combined CR and rhizomania resistance were selected. The seed increased on the roots of these selected plants will be released as CR09 and CR10.

CR09 and CR10 are multigerm lines with moderate resistance to *Cercospora* and rhizomania, conditioned by Rz. These lines segregate for genetic male sterility and self-compatibility. Based upon greenhouse selfing, about half of the plants are self-fertile (S^f) and half self-sterile (S^sS^s). Two accessions (R105 & R106) from the breeding program of Enrico Biancardi that possessed CR were crossed to genetic male sterile plants of populations 747 and 911. These crosses were selected for resistance to rhizomania. These synthetics (R107 & R108) were then pair crossed to population 915. Each pair cross was maintained separately as a family. These pair cross families were grown in a progeny test under *Cercospora* and rhizomania conditions in 1993. The most resistant plants within the most resistant pair crosses were selected, pooled, and increased. Individual plants within those new lines (R409 & R410) were selected for combined resistance to CR-Rz in 1995 and increased separately to form CR09 (R609) and CR10 (R610) in 1996.

CR09 and CR10 are similar, each having 25% of their germplasm base from Italian CR lines and 75% from populations with adaptation to the Western USA. These lines show tolerance or intermediate levels of reaction to curly top, bolting, *Erwinia*, and powdery mildew. They have average performance for sugar yield and sucrose concentration. Their performance in hybrids has not been evaluated. In addition to having resistance to *Cercospora* and rhizomania,

these lines should have genetic variability for most disease resistant traits needed in the Western USA. They will probably be most useful as sources for selecting breeding lines with CR combined with other disease resistances. Either self-fertile or self-sterile lines could be developed with or without segregation for genetic male sterility. One suggested course of action would be to increase these lines through the male-sterile segregates and then generate S₁ progenies for progeny testing and selection for the specific combination of traits desired.

Test 7195 shows the relative level of reaction to *Cercospora* among commercial hybrids from Europe and USA. As in southern Europe, this test showed that Monodoro has higher CR than rhizomania resistant Rizor.

REACTION TO CERCOSPORA LEAF SPOT, SALINAS

<u>Variety</u>	<u>Description</u>	<u>CLS Score</u>
Monodoro	CLS resist. hybrid	1.6
Rizor	Rhizom. resist. hybrid	4.9
Stratos	German hybrid	6.4
US H11	Susc. check	2.9
SS-781R	Spreckels	2.5
4581	Betaseed	2.9
Rival	Holly	2.0
- - - - -		
LSD(.05)		1.0

Test 7195. Plntd. 5-31-95. Harvd. 11-16-95.

CLS: Natural infection where 0 = highly resistant and 9 = complete defoliation.

Test 6495 had more severe *Cercospora* infection than 7195, but the relationship between US H11 and Rizor was similar. By inference then, these relationships suggest that R409 and R410 have a similar level of CR as Monodoro. Under the combined conditions of *Cercospora* and rhizomania, R409 and R410 have equal or better performance than Rizor.

REACTION TO CERCOSPORA LEAF SPOT, SALINAS

<u>Variety</u>	<u>Description</u>	<u>CLS Score</u>	<u>Sugar lbs/a</u>
Rizor		6.1	7100
US H11		4.9	3100
R105	Italian CR source	3.9	5200
R409	CR sel.(CTR,Rz*2 x CR)	3.0	7300
R106	Italian CR source	3.3	4800
R410	CR sel.(CTR,Rz*2 x CR)	3.5	7700
- - - - -			
LSD (.05)		0.8	900

Test 6495. Plntd. 5-31-95. Harvd. 11-28-95.

Severe rhizomania. Moderate LS late.

CR = *Cercospora* resistant line; CTR = curly top resistant line with Rz resistance to BNYVV.

C51, A PROPOSED RELEASE IN 1996 - C51 is an improved synthetic of C50. C51 is a multigerm, self-sterile line with high resistance to rhizomania. It also appears to have genetic variability for reaction to virus yellows and most other diseases. C51 may also have potential as a new source of genetic variability for the components of sugar yield.

C50 was released in 1988 as an unimproved germplasm line that combined an adapted sugarbeet line Y54 (later released as C54) with about 60 accessions of *Beta maritima*. C50 is half *Beta maritima*. C51 is a recombination of eight subpopulations of C50 that had been improved by 4 to 6 cycles of recurrent phenotypic selection for different combinations of resistance to rhizomania and virus yellows, biennialism, beet conformation, sucrose concentration, and root yield. The component lines of C51 have been tested as versions of line R22, e.g., R422Y3 & R422R5. Mother roots that had been selected for resistance to rhizomania under severe conditions and reselected on the basis of root shape and sucrose concentration were recombined to produce line R522, released as C51.

Synthetics of C50 (R22R lines) that were selected for resistance to rhizomania have performed very well under severe rhizomania. In tests at Salinas and Brawley, Ca, they often have had higher sugar yield than commercially available rhizomania resistant hybrids. At Brawley, under rhizomania conditions, these synthetics have shown high resistance to high temperature root rots.

Synthetics of C50 (R22Y lines) that were selected for resistance to virus yellows (BYV/BWYV) and for sucrose concentration have performed relatively well under both infected and noninfected conditions. Under VY conditions, performance suggests genetic variability for tolerance to VY. Under nondiseased conditions, these R22Y lines have had surprisingly good sucrose levels and suggest that C51 might be a source for new genetic variability for sugar concentration and yield.

Because of apparent high resistance in C51 material to rhizomania, high temperature root rot under rhizomania conditions, tolerance to virus yellows, and performance for components of sugar yield, the resistance factors for rhizomania and virus yellows are being backcrossed into sugarbeet backgrounds with concurrent reselection. C79-8, tested as breeding line R36, and lines R444 and R443 are examples from this program. The performance of this breeding material is shown throughout the summary tables in this Report and in previous Sugarbeet Research Reports. Shown below are examples from tests 5095 and B995.

RHIZOMANIA RESISTANCE FROM *B. MARITIMA*

Variety	Description	Sugar (lbs/a)	
		Salinas	Brawley
US H11		5500	6800
4581	Betaseed	8600	--
C31/6	VYR breeding line	5800	--
R476	C31/6 Rz	8200	8700
R443	BC ₂ F ₂ (C31/6*3 x <i>B.maritima</i>)	8800	9700
4284	BC ₃ F ₁ (C31/6*4 x <i>B.maritima</i>)	8000	--

LSD (.05)		700	900

Test 5095, Salinas. Pltd. 5-4-95. Harvd. 10-17-95.
 Test B995, Brawley. Pltd. 10-3-94. Harvd. 5-23-95.

RHIZOMANIA RESISTANCE FROM *B.maritima*

Variety	Description	Sugar(lbs/a)
US H11		5500
4581	Betaseed	8600
R423B	<i>B.maritima</i> (UK composite)	5600
C37	susc. sugarbeet line	5300
R426	F ₁ (C37 x <i>B.maritima</i>)	6500
R436	BC ₂ F ₂ (C37*3 x <i>B.maritima</i>)	8200
R479	C37 Rz = C79-1	6700

LSD (.05)		700

Test 5095. Pltd. 5-4-95. Harvd. 10-17-95.
Moderate rhizomania, Salinas, CA.

The breeding line C31/6 has been converted to a near-equivalent rhizomania line R476 using the Rz factor. In comparison to R476, line R443 with resistance to rhizomania from R22 (C50), shows better performance under severe rhizomania. Likewise, R479 (C79-1), the Rz version of C37, does not perform as well under rhizomania conditions as R436 (C79-8), where resistance was derived from C50.

R423B is an increase of rhizomania resistant roots from *B.maritima* from U.K. R426 is an unselected F₁ from C37 x these *B.maritima* selections. Using genetic markers and resistance to rhizomania, R426 will be advanced and evaluated as a source of new genetic variability to improve sugarbeet.

POWDERY MILDEW RESISTANCE - *Beta maritima* lines WB97 and

WB242 are known to have individual plants with near-immunity to powdery mildew. This resistance has been backcrossed into sugarbeet line C37 that is susceptible to powdery mildew. These backcross derived lines were tested in the field in tests 1295 and 6195 and were identified as P401, P402, P403, P404, and P405. On a plot basis, these lines were scored as being intermediate for powdery mildew reaction. However, when individual plants were evaluated, most were either equal to C37 for reaction or highly resistant. The nearly discrete segregation pattern suggested that resistance from WB97 and WB242 was dominant and simply inherited. From test 6195, individual plants with high resistance were selected. These will be used in 1996 to set up an inheritance of resistance evaluation and to continue to move this resistance into a useful sugarbeet base line. A second objective of tests 1295 and 6195 was to determine if variability for virulence occurred within the powdery mildew inoculum in the field that would overcome this simply inherited resistance and defeat its usefulness. Within the limited scope of these 1995 tests, this breakdown of resistance did not occur.

NEMATODE RESISTANCE FROM WB242 AND B883 - The same *Beta*

maritima line WB242, that has near-immunity to powdery mildew, was previously found in Europe (IRS, Bergen op Zoom, the Netherlands) to have resistance to sugarbeet cyst nematode (SBCN). From P202 in 1992, individual plants were selected for resistance to SBCN and increased to produce P402NR (see tests 1295 and 6195). In test 1295 that had a SBCN infestation, P402NR performed well. P402NR was also grown in tests 5795 and 6795 (not included in the summary tables) for selection of nematode resistant (NR) plants. Test 5795 was grown under high SBCN infestation at Spence Field and 6795 in Field C under moderate infestations. On 11 Nov. 95, plants from test 5795 were scored

visually for reaction to SBCN on the basis of resistance (no white cysts observed) versus susceptibility (one or more cysts observed). Test 6795 was scored 28 Nov. 95 and resistant plants selected for increase. The scores of resistant to susceptible plants are shown in the following table.

Variety	Description	Reactions to SBCN			
		Test 5795		Test 6795	
		R No.	S No.	R No.	S No.
US H11	Susc. check	5	88	13	90
4581	Susc. check	21	112	12	53
P402NR	BC ₂ F ₃ (C37*3 x WB242)	64	50	98	221
N499	Inc. KWS NR-B.m.	74	17	29	12
N801	Inc. B883			46	3
C603	Homoz. SBCN resist.			116	0
N457	C608 (BC ₃ F ₂)	60	37	51	65
N461	C609 (BC ₃ F ₂)	55	41	60	52
N303H52	F ₁ CMS(NS) x C603	117	26	57	9

Based upon the susceptible checks US H11 and 4581, escapes occurred. However, differences in frequency between the susceptible checks and the lines with NR from WB242 and B883 suggested that NR plants occurred and probably could be effectively selected.

S₁ PROGENY TESTS

- Self-fertile, genetic male sterile facilitated, random-mated populations have been under development at Salinas since about 1967. These were some of the first populations to be converted to rhizomania resistance. The major advantages of these S₁Aa populations is that individual fertile (Aa) plants can be selfed to produce S₁ progeny and that selected S₁'s can be topcross tested or recombined through the genetic ms segregates. In 1994, plants from populations were selfed under paper bags in the greenhouse. In 1995, in test 395, for evaluation of bolting tendency and reaction to *Erwinia*, and test 5395, for resistance to rhizomania and performance traits, S₁ progenies were evaluated. Based upon the performance of these progenies, mother roots were selected from within the best lines. Most of these roots will be recombined in 1996. From a few of the apparent best S₁ progenies, individual lines will be increased separately and crossed onto a CMS tester. On the basis of the disease resistance and hybrid performance of these individual lines, one or more may be released in the future as advanced breeding lines. Because two of the populations (C918 and C911-4) have already been released, the performance of the S₁ progenies is summarized below to give general information about the merits of these populations. More detailed information is given in tables 395 and 5395.

RANGE OF PERFORMANCE OF S₁ PROGENIES

Trait	Source popn	No. S ₁ Lines	Range		Mean
			Low	High	
<u>TEST 5395</u>					
Sugar Yield (lbs/a)	915	29	5130	10713	8114.59
	C918	46	4668	12329	8014.61
	C911-4	22	6124	10501	8581.82
% Sugar	915	29	13.0	16.3	14.76
	C918	46	13.2	17.1	15.47
	C911-4	22	14.3	17.5	15.68
Powdery Mildew	915	29	1.0	3.0	1.83
	C918	46	1.0	4.5	1.91
	C911-4	22	1.0	3.0	1.80
Rhizom. - DI	915	29	2.6	4.3	3.09
	C918	46	2.8	4.6	3.40
	C911-4	22	3.0	3.7	3.30
Rhizom. - %R	915	29	40.0	100	91.74
	C918	46	30.0	100	80.12
	C911-4	22	70.8	100	88.95
<u>TEST 395</u>					
% Bolting	915	40	0.0	53.6	11.77
	C918	62	0.0	45.8	5.18
	C911-4	42	0.0	12.5	1.13
Erwinia - DI	915	40	0.0	87.7	13.55
	C918	62	0.0	66.7	10.64
	C911-4	42	0.0	44.5	9.06
Erwinia - %R	915	40	12.0	100	82.58
	C918	62	30.0	100	85.51
	C911-4	42	50.0	100	85.13

SOLARIZATION AND FUMIGATION TO CONTROL RHIZOMANIA

- In a trial with Anne Wrona, U.C. Cooperative Extension, Imperial County, California, trials were run to determine the effects of soil treatments and sugarbeet varieties on rhizomania in the Imperial Valley of California. The first year's results were summarized in the 1994 Sugarbeet Research report. In 1994-95, two experiments were conducted. Test B595 was to evaluate the carry-over effects of the soil treatments to see if the costs of solarization or fumigation could be amortized over multiple crops or years. The second trial, test B695 was essentially a repeat of the first year's test.

Test B595 was planted with a single rhizomania susceptible variety HH41. The entire area where the 1994 trial was grown was used. Within this planting, the treatments were laid out as closely as possible to match the 1994 soil treatments. For the 1995 trial (test B595), four treatments and two harvest dates were used.

The results of B595 are shown below and in the main part of this report under Imperial Valley trials. Too little nitrogen was applied to this test, so after an excellent start and differentiation among treatments, the plants ceased to grow and all treatments yellowed. Despite this, the relative

effects were very close to what would be expected. Of the eight possible interaction means, only the two extremes are shown in Table 1.

Table 1. CARRY-OVER EFFECTS OF SOLARIZATION AND FUMIGATION ON SUGARBEET PERFORMANCE

<u>Soil Trtmt</u>	<u>Sugar lbs/a</u>	<u>Roots t/a</u>	<u>Sucrose %</u>	<u>Rot %</u>
Control	1900	6	14.6	44
Solarization	3700	11	16.7	15
Vapam	1500	5	14.3	43
MB/Chl	5500	17	16.3	10
<u>Harvest Date</u>				
20 May 1995	3900	11	16.9	10
6 July 1995	2400	8	14.1	46
<u>Interactions</u>				
Control x July	900	4	13.3	69
MB/Chl x May	6200	18	17.7	3

Test B595, Brawley, CA. Planted 10-19-94 to HH41.

At the July harvest, soil samples were taken from the soil treatments and cyst nematodes counted. In 1994, both the methylbromide (MB) and solarization treatments caused decreased counts. However, for the 1995 trial, the counts were higher in the MB and solarization treatments relative to the nontreated check. These results suggested that the counts in the control plots at the end of the second season were naturally suppressed due to antagonistic organisms that had not been depleted by fumigation or solarization. Both of these treatments, however, apparently reduced the suppressive effect which resulted in the increase of the cyst nematode population (Table 2).

Table 2. CYST NEMATODE FOLLOWING 2ND SUGARBEET CROP

<u>Treatment</u>	<u>1993-94</u>		<u>1994-95</u>	
	<u>eggs/g</u>	<u>eggs/cys</u>	<u>eggs/g</u>	<u>eggs/cys</u>
Nontreated	40	15	22	11
MB/Chl	25	11	23	15
Solarization	18	8	37	22

Test B595, Brawley, CA. Top 30 cm of soil.
From Becker, Wrona, Lewellen, 1996.

Test B695 is summarized in Table 3 and in more detail in the main body of this report. Relative to the trial in 1994, Test B695 was under less severe rhizomania. The soil treatments were again nontreated check or control, solarization, MB/Chl (methylbromide/chloropicrin), and Vapam (metam sodium). Varieties for 1995 were partially changed. In addition to susceptible HH41 and partially resistant Rhizoguard, 4915H93, an Rz experimental USDA hybrid, and R422R4H52, an experimental USDA hybrid with rhizomania resistance from *B.maritima*, were used. Two dates of harvest were made.

Table 3. EFFECTS OF TREATMENTS ON SUGARBEET
PERFORMANCE UNDER RHIZOMANIA

<u>Soil Treatment</u>	
Control (nontreated)	
Solarization (6 weeks August-September)	
Vapam	
Methyl Bromide/Chloropicrin (75:25 @ 350 lbs/a)	
<u>Variety</u>	
HH41	Susceptible check
Rhizoguard	Moderately resistant (Rz)
4915H93	USDA Exp Hybrid (Rz)
R422R4H52	USDA Exp Hybrid (<i>B.maritima</i>)
<u>Harvest Date</u>	
20 May 1995	
6 July 1995	
Test B695, Brawley, CA. Planted 10-19-94.	

The main effects for the soil treatments are shown in Table 4. Unlike 1994, the highest yield was achieved by the solarization treatment rather than the MB treatment.

Table 4. EFFECTS OF SOIL TREATMENTS ON SUGARBEET
PERFORMANCE UNDER RHIZOMANIA

<u>Soil Trtmt</u>	<u>Sugar lbs/a</u>	<u>Roots t/a</u>	<u>Sucrose %</u>	<u>Rot %</u>
Control	5500	20	13.6	13
Solarization	9200	33	14.2	1
Vapam	7000	26	13.6	5
MB/Chl	8300	29	14.2	0
LSD (.05)	600	2	0.4	5
Test B695, Brawley, CA. Planted 10-19-94.				

For the main effects for varieties over all of the other treatments, R422R4H52 gave the highest yield (Table 5).

Table 5. EFFECTS OF VARIETIES ON SUGARBEET
PERFORMANCE UNDER RHIZOMANIA

<u>Variety</u>	<u>Sugar lbs/a</u>	<u>Roots t/a</u>	<u>Sucrose %</u>	<u>Rot %</u>
HH41	7200	26	13.5	8
Rhizoguard	6900	24	14.3	2
4915H93	7100	25	14.3	6
R422R4H52	8800	33	13.4	3
LSD (.05)	600	2	0.4	5
Test B695, Brawley, CA. Planted 10-19-94.				

The harvest date main effects are shown in Table 6. Over all of the other treatments, there was little difference in sugar yield between the two dates.

Table 6. EFFECTS OF HARVEST DATES ON SUGARBEET PERFORMANCE UNDER RHIZOMANIA

<u>Harvest Date</u>	<u>Sugar lbs/a</u>	<u>Roots t/a</u>	<u>Sucrose %</u>	<u>Rot %</u>
20 May 1995	7400	25	14.9	3
6 July 1995	7600	29	12.8	7
	NS	**	**	**

Test B695, Brawley, CA. Planted 10-19-94.

Of the possible 16 interactions over soil treatments and varieties, only 4 are shown in Table 7. These results are what would be expected. The lowest yield was for control x HH41. The most resistant variety, R422R4H52, had much higher yield than susceptible HH41 under the nontreated control conditions. However, under the solarization treatment that apparently give high control of rhizomania, the commercial hybrid HH41 had higher yield than the experimental hybrid with *B.maritima* germplasm. These comparisons of the effects of rhizomania on yield and the efficacy of resistance are as good as ever measured in tests in California.

In comparison to the yield of solarization x HH41, moderate rhizomania caused a yield loss of 56% for susceptible HH41. The resistant variety R422R4H52, under rhizomania conditions, was 74% higher in yield than HH41 but in comparison to the nondiseased solarization treatment had a 20% reduction in yield. Thus the present level of resistance did not fully protect against the losses caused by rhizomania. Some of this difference is probably also due to the effects of other soil-borne factors that were controlled or moderated by solarization. Nonetheless, these results show the importance of avoiding rhizomania infestation. In the tested resistant hybrids, the resistance factors at best were heterozygous and fewer than 100% of the plants would have had resistance, possibly also accounting for some of this difference.

Table 7. EXAMPLES OF INTERACTIONS OF SUGARBEET PERFORMANCE UNDER RHIZOMANIA

<u>Soil Treatment x Variety</u>	<u>Sugar lbs/a</u>	<u>Rot %</u>
Control x HH41	4300	21
Control x R422R4H52	7500	7
Solarization x HH41	9800	0
Solarization x R422R4H52	9400	1
LSD(.05)	1200	10

Test B695, Brawley, CA. Planted 10-19-94.

Four of the possible eight interactions for soil treatment x harvest date are shown in Table 8. As experienced in past trials under rhizomania conditions, there is a loss of yield as the warm season progresses. However, when rhizomania is controlled with solarization, there is a significant increase in yield over the longer season.

Table 8. EXAMPLES OF INTERACTIONS OF SUGARBEET PERFORMANCE UNDER RHIZOMANIA

<u>Soil Treatment x Harvest Date</u>	<u>Sugar lbs/a</u>	<u>Rot %</u>
Control x May	6000	6
Control x July	5000	20
Solarization x May	8800	2
Solarization x July	9600	0
LSD (.05)	500	6
Test B695, Brawley, CA. Planted 10-19-94.		

For the four variety x harvest date interactions shown in Table 9, HH41 has significantly lower yield at the second date of harvest. The opposite is true with R422R4H52.

Table 9. EXAMPLES OF INTERACTIONS OF SUGARBEET PERFORMANCE UNDER RHIZOMANIA

<u>Variety x Harvest Date</u>	<u>Sugar lbs/a</u>	<u>Rot %</u>
HH41 x May	7600	1
HH41 x July	6800	14
R422R4H52 x May	8300	4
R422R4H52 x July	9300	2
LSD (.05)	500	6
Test B695, Brawley, CA. Planted 10-19-94.		

Of the possible 32 three-way interactions, only the extremes are shown in Table 10. As might be expected, the very lowest yield is for no soil treatment with a susceptible variety at the last harvest date, when many of the roots had died or were rotted. The highest yield was for either MB or solarization treatments with a resistant variety at the last date of harvest.

Table 10. EXAMPLES OF INTERACTIONS OF SUGARBEET PERFORMANCE UNDER RHIZOMANIA

<u>Soil Trtmt x Variety x Harvest Date</u>	<u>Sugar lbs/a</u>	<u>Rot %</u>
Control x HH41 x July	3000	40
MB/Chl x R422R4H52 x July	10000	2
Solarization x R422R4H52 x July	10300	0
LSD (.05)	1000	11
Test B695, Brawley, CA. Planted 10-19-94.		

Although the results from 1994 were very impressive due to the extreme severity of rhizomania, these 1995 results are probably much closer to what a grower would encounter at the present levels of rhizomania infestation in the Imperial Valley.

INDEX OF VARIETY TRIALS, SALINAS, CA, 1994-95

USDA-ARS. U.S. AGRICULTURAL RESEARCH STATION

R.T. LEWELLEN

Tests were located in five fields and established at six planting dates. All tests were under rhizomania infested soil conditions, except those in Block 5. Nortron, Pyramin, and Betamix were applied for weed control. Bayleton was used to control powdery mildew except in powdery mildew evaluation trials. Lorsban-4E was applied to some tests for insect control. The specific planting and harvest dates as well as plot size and design are shown on each test summary.

Tests are listed in this report by type of material and evaluation as shown in the main table of contents for Salinas. As an aid to find test summaries, they are listed below by ascending test number and cross referenced to the page number. Tests shown as N/A for page number were not included in this Report.

<u>TEST NO.</u>	<u>NO. ENTRIES</u>	<u>TEST DESCRIPTION</u>	<u>PAGE NO.</u>
<u>BOLTING EVALUATION TESTS, BLOCK 2N, PLANTED NOVEMBER 1994</u>			
195	120	Evaluation of Hybrids	A139
295	19	Selection for Nonbolting	A135
395	240	Eval. of MM,S',Aa S ₁ Progeny	A142
495	240	Eval. of mm,S',Aa Progeny	N/A
595	120	Eval. of 4918A Progeny	N/A
695	120	Evaluation of Lines	A136
<u>POWDERY MILDEW EVALUATION, BLOCK 5, APRIL 1995</u>			
1095	108	Powdery Mildew Progeny Test	N/A
1195	234	Coded Powdery Mildew	N/A
1295	12	Eval. of PMR Lines	A53
<u>VIRUS YELLOWS (BYV/BWYV) EVAL., BLOCK 5, APRIL 1995</u>			
1395	12	VY Eval. of R22 Lines & Hybrids	A49
1495	24	VY Eval. of MM Lines	A37
1595	24	VY Eval. of Hybrids	A65
<u>NON-DISEASED YIELD TESTS, BLOCK 5, APRIL 1995</u>			
1695	12	Performance of mm Populations	A58
1795	48	Performance of MM Lines	A34
1895	12	IIRB & USDA Hybrids	A70
1995	24	Hybrid Eval. of MM Lines	A63
2095	12	Hybrid Eval. of MM,S',Aa Lines	A64
2195	24	Topcross Eval. of mm Lines	A61
<u>SEVERE RHIZOMANIA, BLOCK 2N, MARCH 29, 1995</u>			
3195	8	Selection for Rhizomania Resistance	N/A
3295	16	Eval. of R22 Lines & Hybrids	A50
3395	16	Eval. of MM Lines	A38
3495	16	IIRB & USDA Hybrids	A72
3595	16	Sources of Resistance in C37	A45
<u>RHIZOMANIA EVALUATION, BLOCK 2S, MAY 3, 1995</u>			
4195	16	Monogerm Populations	A59
4295	24	Transgenic Resistance To BNYVV	N/A
4395	16	Eval. of R22 Lines & Hybrids	A51

<u>TEST NO.</u>	<u>NO. ENTRIES</u>	<u>TEST DESCRIPTION</u>	<u>PAGE NO.</u>
<u>RHIZOMANIA EVALUATION, BLOCK 2S, MAY 3, 1995 (cont.)</u>			
4495	16	IIRB & USDA Hybrids	A74
4595	32	Western Sugar/Holly Growers Hybrids	A78
4695	96	CBGA Coded & Other Hybrids	A86
4795	16	Hybrid Eval. of MM,S ^f ,Aa Lines	A66
4895	32	Hybrid Eval. of MM Lines	A67
4995	16	Sources of Resistance in C37	A46
5095	64	Eval. of MM Lines	A39
5195	256	Progeny Evaluation	N/A
5295	64	Progeny Evaluation	N/A
5395	128	Eval. of MM,S ^f ,Aa S ₁ Progeny	A148
5495	24	Topcross Eval. of mm Lines	A62
5595	16	Sources of Resistance in Polycrosses	A48
5695	8	Eval. of mm Lines	A60
5795	16	SBCN Resistance Evaluation	N/A
<u>POWDERY MILDEW EVALUATION, FIELD C, MAY 31, 1995</u>			
6195	12	PM Eval. and Resist. Selection	A54
6295	32	PI Eval. of Egyptian B.m.	A44
<u>CERCOSPORA EVALUATION, FIELD C, MAY 31, 1995</u>			
6395	12	Rhizomania Eval. Fort Collins Lines	FC
6495	12	CR-Rz Eval. & Selection	A55
<u>RHIZOMANIA EVALUATION, FIELD C, MAY 31, 1995</u>			
6595	48	Progeny Test	N/A
6695	4	Resistance Selection	N/A
6795	24	SBCN-Rz Eval. & Selection	N/A
6895	16	Eval. of R22 Lines & Hybrids	A52
6995	16	Sources of Resistance in C37	A47
7095	16	Eval. of MM Lines	A43
7195	16	IIRB & Commercial Hybrids	A76
7295	16	Eval. of Experimental Hybrids	A69
7395	6	Selection for Rhizomania Resistance	N/A
<u>RHIZOMANIA RESISTANCE SEL., FIELD A, AUGUST 7, 1995</u>			
--	208	Selection for Rhizomania Resistance	N/A
--	63	Selection for SBCN/RZM Resistance	N/A

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Project #203: Characterization of Furoviruses Infecting Sugarbeets

G. C. Wisler, J. E. Duffus, and H.-Y. Liu

Previous studies at the USDA-ARS in Salinas have addressed the comparison of several beet necrotic yellow vein virus (BNYVV) isolates (two from California, one each from Colorado, Idaho, and Nebraska) and several isolates which are serologically identical to beet soil borne mosaic virus isolates 1 and 2 (BSBMV-1 and -2; originally called Texas-7 and -8) using immunodiffusion, ELISA, western blot analysis, host range comparisons and polymerase chain reaction (PCR). The emphasis for this project lies in the understanding of the diversity of BNYVV and related furoviruses that exist in sugarbeet roots and soil. This understanding is crucial to the accurate and sensitive detection of these viruses, particularly in light of the regulatory restrictions involved in the Rhizomania disease of sugarbeet. The primary conclusions from our previous research are that virtually all BNYVV isolates studied from the U.S. are identical to one another, suggesting a single introduction into the U. S. In contrast, all of the isolates which were originally thought to be identical to BSBMV-1 and -2 from Texas, based on serological identity of the coat protein, are a heterogeneous group and are more likely to have originated and developed here in the U.S.

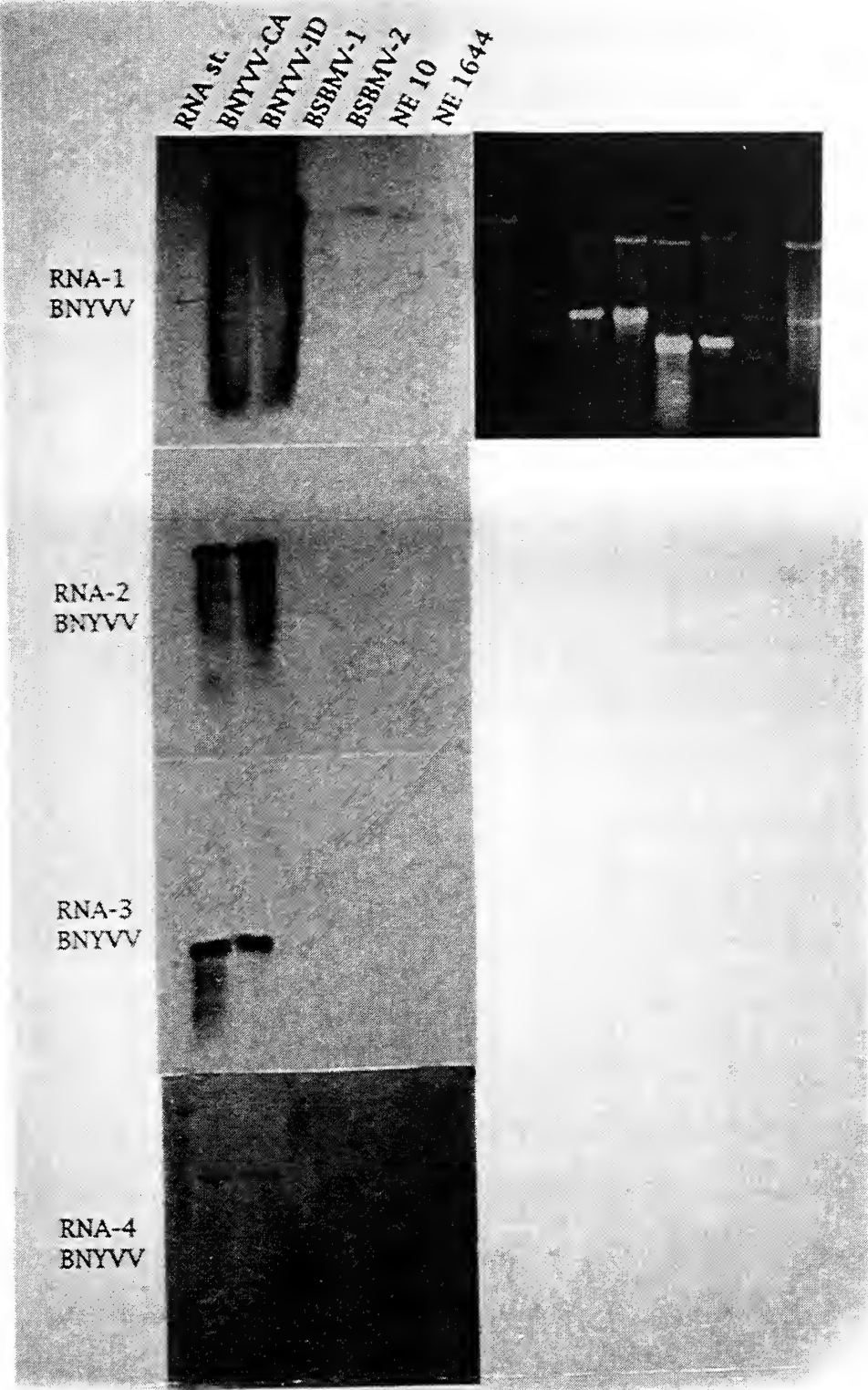
Recent molecular analyses of the furoviruses addressed in this study suggest similar results as seen previously. Two BNYVV isolates and four isolates serologically identical to BSBMV-1 and -2 were purified, their RNA's extracted and analyzed for determination of the number and relative sizes of their RNAs. These isolates were also tested for polyadenylation of the 3' end of the RNAs. This characteristic is unique to BNYVV within the furovirus group, and is unlike the furovirus type member, wheat soil-borne mosaic virus (WSBMV). All of the isolates tested were polyadenylated, thus belong to the BNYVV subgroup, which has been suggested in the literature to be called the Benevirus group. In addition, all isolates contained at least three RNAs, again more like BNYVV than WSBMV, which has only two RNAs.

The RNA analysis of the BNYVV isolates revealed only RNA 1, 2, and 3 (see Figure). This is not surprising, as according to the literature, RNA 4 can be in such a low concentration as to not be detected by standard methods. Also, RNA 4 can be lost after only a few mechanical transfers. Our isolates are handled as to minimize this loss, but it is still possible. The two isolates from Texas had only three RNAs, with RNA 3 being smaller than that reported for BNYVV RNA 3 or RNA 4 (Table and Figure). The two isolates that are serologically identical to BSBMV capsid protein, NE 10 and NE 1644, had again, different RNA patterns. NE 10 had a pattern more like BNYVV, but with a very small RNA 4 at 0.9 kb (Table and Figure). The isolate NE 1644 also showed an RNA pattern more like BNYVV than BSBMV. This isolate is especially interesting because it is the first furovirus isolate known which has a host range outside the Chenopodiaceae. The NE 1644 infects *Nicotiana benthamiana* and *N. clevelandii*, whereas no other furovirus isolate tested in our lab is known to infect a tobacco species.

To date, clones representing all four RNAs of BNYVV have been labeled as nonradioactive probes and used in Northern analysis of the isolates addressed in this study (Figure). RNA 1, 2, and 3 of BNYVV are specific for the BNYVV isolates tested. The RNA 4 probe of BNYVV reacted with the RNA 3 of BSBMV-1 only (not with that of BSBMV-2) and with the RNA 3 of NE10. This is the first definable difference seen between BSBMV-1 and -2, aside from a slight difference in host range. BSBMV-2 has been cloned, the RNAs 1, 2, and 3 have been partially sequenced, and their sequences have been compared to those in the gene banks. The 3'-1,000 bases of BSBMV-2 RNA 2 has a 81% similarity to the BNYVV RNA 1. This area represents a portion of the replicase gene. Although 81% is a relatively high similarity, it is still considered to be distinct with regard to individual viruses. The 3'-1,000 bases of RNA 2 shows a 60% sequence similarity with that of BNYVV. This area corresponds to the proposed cell-to-cell movement protein region of BNYVV. Interestingly, the BSBMV RNA 3 aligned with the RNA 5 of the Japanese isolate of BNYVV (Kiguchi

et al., 1995), with a 55% nucleic acid similarity, and a 60.3% amino acid similarity.

The molecular analyses of the BNYVV and BSBMV isolates in this study indicate, as the serological analyses did, that the BNYVV isolates represent a homogeneous group, and that the BSBMV isolates represent a heterogeneous group. However, there are several interrelationships between and among these two groups. The molecular analyses confirm the serological analyses which indicate that the BSBMV-related isolates are distinct from BNYVV isolates in the U.S.



a kilobases
bnd=not detected

Approximate Sizes of RNA Components from Several Furoviruses of Sugar Beet						
RNA component	BNYVV-CA	BNYVV-ID	BSBMV-1	BSBMV-2	NE10	NE 1644
RNA-1	6.7a	6.7	6.5	6.7	6.7	6.7
RNA-2	4.7	4.7	4.5	4.7	4.7	4.7
RNA-3	1.8	1.8	1.3	1.4	1.8	1.8
RNA-4	nd ^b	nd	nd	nd	0.9	nd

TEST 1795-1,2,3. PERFORMANCE OF GERmplasm LINES, SALINAS, CA., 1995

48 entries x 8 replications, RCB (equalized); 3 subtests: 16 x 8, RCB (e) Planted: April 14, 1995
 1-row plots, 21 ft. long Harvested: September 25-26, 1995

Variety	Description	Acre Yield		Sucrose	Root	Beets/ 100'	Powdery Mildew	Bolting	RJAP
		Sugar	Beets						
		Lbs	Tons	%	%	No.	%	%	%
1795-1: Sources of Resistance to RZM in C37 Background									
U86-37	Inc. C37	7281	26.60	13.70	0.0	147	5.5	0.0	76.7
R479(Iso)	C79-1, Rz, RZM R379	8247	31.46	13.11	0.0	146	4.8	0.0	77.1
R424	C79-2, WB41, RZM 3250	8705	31.30	13.91	0.0	151	5.4	0.0	76.4
R425	C79-3, WB42, RZM 3251	7483	27.61	13.57	0.0	139	5.6	0.0	76.7
R428	C79-4, PI04, RZM 3202	7600	27.32	13.90	0.0	146	5.7	0.0	77.5
R432	C79-5, R04, RZM 3201	7818	29.72	13.15	0.0	141	5.4	0.0	76.0
R434	C79-6, R05, RZM 3245	8723	31.92	13.69	0.0	136	5.7	0.0	77.3
R435	C79-7, SES, RZM 3242	9097	31.51	14.44	0.0	142	5.8	0.0	77.6
R436	C79-8, R22, RZM 3243	8246	32.35	12.75	0.0	141	5.5	0.0	76.6
R437	C79-9, WB151, RZM 3247	8166	29.28	13.94	0.0	146	4.8	0.0	76.6
R441	C79-10, WB169, RZM 3248	7785	29.09	13.39	0.0	140	5.1	0.0	76.4
R442	C79-11, WB258, RZM 3249	8722	31.67	13.79	0.4	140	4.7	0.9	77.5
R440-9	RZM 3243 x RZM R40(C)	7771	29.51	13.19	0.0	151	4.9	0.3	76.3
R440H18	3918aa x RZM R40(C)	9895	35.92	13.77	0.0	142	4.5	0.0	77.6
Rizor	RZ3/1022, 1993	9938	31.80	15.64	0.0	148	6.1	0.0	78.6
US H11	11-16-94	8673	32.73	13.27	0.0	152	5.5	0.0	76.7
Mean		8384.5	30.61	13.70	0.0	144.2	5.3	0.1	77.0
LSD (.05)		613.9	2.26	0.43	0.3	12.4	0.3	0.5	2.2
C.V. (%)		7.4	7.45	3.19	1339.2	8.7	6.5	625.2	2.9
F value		13.0**	8.60**	18.30**	1.0NS	1.2NS	13.9**	1.9*	0.7NS

TEST 1795-1,2,3. PERFORMANCE OF GERmplasm LINES, SALINAS, CA., 1995

48 entries x 8 replications, RCB (e). ANOVA to compare means across sets of entries.

Mean	9075.9	33.26	13.64	0.1	143.0	4.9	0.2	77.1
LSD (.05)	651.8	2.29	0.46	0.7	12.9	0.4	1.3	2.4
C.V. (%)	7.3	6.97	3.45	614.7	9.1	7.7	812.9	3.1
F value	15.4**	13.72**	11.93**	1.2NS	1.5NS	18.3**	2.3**	1.4NS

NOTES: See tests 1495 and 5095. For 1795-1, also see tests 4995, 6995, and 3595.

TEST 1795-1,2,3. PERFORMANCE OF GERmplasm LINES, SALINAS, CA., 1995

(cont..)

Variety	Description	Acre Yield		Sucrose %	Root Rot %	Beets/ 100' No.	Powdery Mildew %	Bolting %	RJAP %
		Sugar Lbs	Beets Tons						
11795-2: Performance of Lines with R22 Germplasm									
6770	High %S check, KWS	10243	34.50	14.84	1.3	149	4.7	0.0	76.4
4454	Comm. check, Betaseed	10643	36.95	14.43	0.6	149	4.3	0.0	79.1
R484	RZM R384	9151	32.52	14.07	0.0	145	4.6	0.0	78.7
R443	RZM 3284,5,P [(R281-89 x ((C37 x R22))]	9148	32.94	13.87	0.0	143	5.9	0.0	78.3
4915	RZM 3915aa x A	9972	36.63	13.61	0.0	148	4.4	0.0	77.5
R444	RZM 3287, [2915aa x (C37 x R22)]	8480	32.04	13.23	0.0	142	4.9	0.0	76.6
R422R5 (Iso)	RZM R322R4 (GSY)	8323	31.89	13.05	0.0	134	5.7	0.9	75.2
R422R4 (Sp)	RZM R322R4, %	7774	30.09	12.93	0.9	148	5.3	4.8	74.6
R422R4H15	3915aa x RZM R322R4, %	9641	35.21	13.69	0.0	148	5.3	0.5	76.9
R422R4H17	5747aa x RZM R322R4, %	9710	37.32	13.02	0.3	149	5.8	0.0	76.5
R422R4H50	F92-790-15CMS x RZM R322R4, %	10314	37.43	13.79	0.0	148	5.0	0.4	77.1
R422Y3 (Sp)	Inc. R322Y3, %	8740	30.97	14.10	0.0	144	4.5	0.0	77.1
R422Y3H15	3915aa x R322Y3, %	10136	36.58	13.84	0.0	146	4.4	0.0	76.8
R422Y3H50	F92-790-15CMS x R322Y3, %	10323	35.79	14.42	0.4	144	4.2	0.0	77.7
R436R2	RZM R336	8525	32.52	13.11	0.4	143	5.7	0.0	76.8
R436R2H50	F92-790-15CMS x RZM R336	10289	38.11	13.52	0.0	151	4.8	0.0	76.0
Mean		9463.2	34.47	13.72	0.2	145.6	5.0	0.4	76.9
LSD (.05)		684.1	2.24	0.52	1.1	12.6	0.3	2.2	2.7
C.V. (%)		7.3	6.57	3.83	458.0	8.8	6.5	545.4	3.5
F value		13.0**	10.57**	9.25**	0.9NS	0.8NS	25.6**	2.3**	1.6NS

TEST 1795-1,2,3. PERFORMANCE OF GERMPLOSM LINES, SALINAS, CA., 1995

(cont.)

Variety	Description	Acre Yield		Sucrose %	Root Rot %	Beets/ 100' No.	Powdery		Bolting %	RJAP %
		Sugar Lbs	Beets Tons				Mildew %			
1975-3: Performance of Multigerm Lines										
268	Inc. 768 (US 75)	7566	30.19	12.52	0.5	145	5.2		0.0	75.5
F86-31/6	Inc. C31/6 (L86263)	8818	31.37	14.07	0.0	134	4.3		0.0	79.4
R476-89-18	RZM R376-89-18, (C76-89-18)	8690	32.08	13.56	0.9	130	4.3		0.0	77.7
R481-43	RZM R381-43	9291	35.84	12.96	0.0	134	4.5		0.0	76.9
R481-89	RZM R381-89	9763	37.95	12.88	0.0	137	4.1		0.0	77.5
R482NB	NB R276-43,-89 (C82)	9721	36.74	13.23	0.0	146	4.1		0.0	76.3
R478NB	NB R278, Y, (C78)	9488	34.23	13.86	0.0	140	4.4		0.0	77.5
R480NB	NB R280, Y, (C80NB)	9920	36.58	13.56	0.0	139	4.7		0.0	77.0
R480-#	RZM-ER R280-#(C), (C80)	9348	33.63	13.89	0.0	135	4.6		0.0	78.2
R480-45	RZM-ER R280-45, (C80-45)	9688	35.21	13.76	0.0	139	4.1		0.0	75.7
R483	RZM R383R	10370	37.58	13.79	0.0	138	4.1		0.0	78.3
4918(Sp)	RZM 3918aa x A	10111	36.21	13.96	0.0	145	4.1		0.0	77.4
R470	RZM R370	9667	36.58	13.22	0.0	141	4.6		0.0	76.9
R410	CR-RZM R210-#(C)	9534	35.05	13.59	0.0	149	5.0		0.0	78.3
Z430	RZM Z330	9548	33.53	14.27	0.0	145	5.2		0.0	78.5
NN457	NR-RZM N357,8(C)(BC ₃ F ₂)	8554	33.13	12.92	0.0	129	4.6		0.0	75.4
Mean		9379.9	34.74	13.50	0.1	139.2	4.5		n/a	77.3
LSD (.05)		702.3	2.50	0.42	0.6	12.8	0.4		n/a	2.4
C.V. (%)		7.6	7.26	3.18	633.8	9.3	8.7		n/a	3.1
F value		7.5**	6.51**	10.76**	1.6*	1.6NS	7.2**		n/a	1.8*

TEST 1495. EVALUATION OF MULTIGERM GERmplasm UNDER VIRUS YELLOWS CONDITIONS, 1995

24 entries x 8 replications, RCB (equalized)
1-row plots, 21 ft. long

Planted: April 21, 1995
Harvested: September 28, 1995
BYV/BWV Inoc.: June 8, 1995

Variety ¹	Description	Acre Yield		Sucrose %	Beets/ 100'	Virus Yellows Score	Powdery Mildew		RJAP %
		Sugar Lbs.	Beets Tons				No.	%	
268	Inc. 768 (US 75)	3643	14.78	12.31	152	8.0	5.9		76.1
6770	Susc., high %S check, KWS	5195	18.85	13.80	155	8.0	6.0		77.4
4454	Comm. check, Betaseed	6823	25.76	13.21	152	7.8	5.3		77.1
F86-31/6	Inc. C31/6 (L86263)	6709	25.04	13.43	145	7.2	4.7		76.6
R476-89-18	RZM R376-89-18 (C76-89-18)	6124	23.25	13.20	148	7.2	4.5		77.1
R481-43	RZM R381-43	6656	25.19	13.21	141	7.5	4.9		78.3
R481-89	RZM R381-89	6636	26.56	12.51	149	7.3	4.4		76.8
R484	RZM R384	7248	26.39	13.74	154	7.3	4.9		78.9
R478NB	NB R278,Y, (C78)	5203	19.77	13.18	154	7.8	5.9		76.9
R480NB	NB R280,Y, (C80NB)	6072	23.25	13.06	136	7.4	5.2		77.2
R480-#	RZM-ER R280-#(C), (C80)	5812	22.02	13.25	148	7.3	4.9		76.5
R480-45	RZM-ER R280-45, (C80-45)	5951	22.20	13.41	152	7.3	4.7		77.3
Y483	RZM R383R	6524	24.86	13.13	149	7.4	4.7		76.6
Y462	Y#rr(C) x RZM R#(C)	7434	27.34	13.61	156	7.4	4.7		78.2
R422Y3 (Sp)	Inc. R322Y3,%	6540	24.39	13.41	150	7.5	4.8		76.2
R410	CR-RZM R210-#(C)	5198	20.37	12.74	139	7.7	5.3		77.0
N457	NR-RZM N357,8(C) (BC ₃ F ₂)	5251	21.76	12.06	141	7.7	5.8		74.9
4918(Sp)	RZM 3918aa x A (C918)	6500	25.34	12.85	158	7.4	4.8		76.8
Z430	RZM Z330	5404	21.02	12.88	152	7.8	5.7		74.9
4911-4M	3911-4Maa x A (C911-4)	5906	23.08	12.84	147	7.4	4.6		75.6
4911-4H90	0790aa x 3911-4m	7050	26.99	13.07	155	7.7	5.4		77.3
4831	3911-4mmaa x mm, O-T	6628	25.55	13.02	155	7.7	5.7		76.9
4890m	RZM 3890mmaa x A	5525	21.54	12.86	151	7.7	5.9		77.5
4893	RZM 3893	4285	17.49	12.31	149	7.7	6.3		76.3
Mean		6013.2	23.03	13.05	149.5	7.5	5.2		76.9
LSD (.05)		564.8	2.02	0.44	11.4	0.2	0.3		4.2
C.V. (%)		9.5	8.91	3.42	7.8	2.6	6.3		2.7
F value		20.7**	19.38**	7.83**	1.9NS	13.8**	23.8**		1.7NS

NOTES: See tests 1795 and 5095 for performance without virus yellows and under rhizomania.

¹ See test 5095. Y462 = recombination of Y-lines x R-lines.

TEST 3395. PERFORMANCE OF RHIZOMANIA RESISTANT LINES UNDER SEVERE CONDITIONS, BLOCK 2-N, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: March 29, 1995
Harvested: October 2-3, 1995

Variety ¹	Description	Acre Yield		Sucrose %	Beets/ 100'	Root		Bolting %	RJAP %
		Sugar Lbs	Beets Tons			No.	%		
US H11	11-16-94	4798	19.80	12.16	120		0.0	0.0	79.6
2J0179	9/9/94, Betaseed	6731	21.34	15.86	103		0.0	0.0	78.8
R470	RZM R370	7329	25.50	14.46	119		0.5	0.0	79.3
R483	RZM R383R	7273	24.78	14.73	111		0.6	0.0	80.3
R478NB	NB R278,Y, (C78)	6978	22.83	15.34	116		0.0	0.0	80.3
R480NB	NB R280,Y, (C78NB)	6462	22.38	14.59	115		0.0	0.0	78.2
R482NB	NB R276-43,-89, (C82)	6226	22.69	13.74	102		0.5	0.0	77.5
R484	RZM R384	6734	23.09	14.60	109		1.1	0.0	80.7
4918 (Sp)	RZM 3918aa x A, (C918)	6551	22.58	14.64	115		0.0	0.0	78.9
R443	RZM 3284,5,P	7614	26.97	14.16	114		3.0	0.0	78.4
R444	RZM 3287	7453	27.61	13.79	113		3.5	0.0	78.3
R422R4 (Sp)	RZM R322R4, %	7885	28.77	13.77	113		3.0	2.9	75.2
4915 (Sp)	RZM 3915aa x A, (C911-4)	6424	22.67	14.30	111		0.0	0.0	79.3
4911-4M	3911-4m,Maa x A	6085	21.18	14.45	120		0.0	0.0	79.8
R410	CR-RZM R210-#(C)	6602	24.15	14.01	102		0.0	0.0	78.4
N457	NR-RZM N357,N358(C608)	5638	20.31	13.94	118		0.0	0.0	78.4
Mean		6673.9	23.54	14.28	112.4		0.8	0.2	78.8
LSD (.05)		989.2	3.69	0.60	15.1		2.0	0.9	1.9
C.V. (%)		15.0	15.82	4.22	13.5		274.0	510.7	2.5
F value		4.9**	3.87**	14.21**	1.3NS		2.8**	4.9**	3.7**

NOTES: See tests 7095, 3395, 1495, 1795, & 5095.

¹See test 7995 for more detailed descriptions.

TEST 5095. RHIZOMANIA EVALUATION OF LINES, BLOCK 2-S, SALINAS, CA., 1995

64 entries x 8 replications, RCB (equalized); 4 subtests: 16 x 8, RCB (e) Planted: May 4, 1995
1-row plots, 20 ft. long Harvested: October 17-18, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100'	Root %	Bolting %	Powdery Mildew Score
		Sugar	Beets					
		Lbs	Tons					
Test 5095-1. 16 x 8 RCB(e).								
US H11	11-16-94	5093	23.05	11.10	183	0.0	0.0	1.6
4581	2-16-94, Betaseed	8619	29.62	14.57	188	0.0	0.0	0.9
Rizor	RZ3/1022 (1-21-93)	9705	29.85	16.24	166	0.0	0.0	1.6
R139C7	RZM R039C6, (C39R7)	7902	29.56	13.36	146	0.0	0.4	0.1
R470	RZM R370	8375	30.77	13.63	158	0.0	0.0	0.1
U86-46/2	Inc. C46/2, 86342	6388	23.16	13.84	164	0.0	0.0	0.5
R478NB	NB R278,Y, (C78)	8944	30.09	14.88	169	0.0	0.0	0.3
R478	RZM R378,Y	9326	31.49	14.80	173	0.4	0.0	0.1
Y954	Inc. Y854, (C54)	6388	23.58	13.56	166	0.0	0.0	0.5
R480NB	NB R280,Y, (C80NB)	8332	29.36	14.19	167	0.0	0.0	0.8
R480	RZM R380,Y	8740	29.83	14.64	165	0.7	0.0	0.3
R480-#	RZM-ER R280-#(C), (C80)	8465	29.46	14.40	160	0.0	0.0	0.6
R480-45(Iso)	RZM-ER R280-45, (C80-45)	8960	29.72	15.07	163	0.0	0.0	0.3
Y462	Y#rr(C) x RZM R#(C)	7863	27.73	14.16	168	0.0	0.0	0.4
R479(Iso)	RZM R379, (C79-1)	6708	25.47	13.16	161	0.0	0.0	0.3
R483	RZM R383(R)	8432	30.98	13.68	166	0.0	0.0	0.1
Mean		8015.0	28.36	14.08	166.3	0.1	0.0	0.5
LSD (.05)		637.8	2.21	0.70	17.1	0.6	0.3	0.6
C.V. (%)		8.0	7.87	5.03	10.4	848.9	1128.6	112.0
F value		30.1**	13.27**	19.60**	2.3*	0.9NS	1.0NS	5.5**

TEST 5095. RHIZOMANIA EVALUATION OF LINES, BLOCK 2-S, SALINAS, CA., 1995
64 entries x 8 replications, RCB (equalized). ANOVA to compare means across sets of entries.

Mean	7811.3	27.78	14.05	164.0	0.2	0.8	0.7
LSD (.05)	704.6	2.33	0.67	16.3	0.8	1.7	0.6
C.V. (%)	9.2	8.52	4.79	10.1	559.1	207.6	84.8
F value	20.7**	17.16**	14.89**	1.8**	1.1NS	36.6**	4.6**

NOTES: See test 1495 for performance of multigerm lines evaluated under virus yellows and test 1795 without disease.

TEST 5095. RHIZOMANIA EVALUATION OF LINES, BLOCK 2-S, SALINAS, CA., 1995

(cont.)

Variety ¹	Description	Acre Yield		Sucrose %	Beets/ 100'	Root %	Bolting %	Powdery Mildew Score
		Sugar	Beets					
		Lbs	Tons					
Test 5095-2. 16 x 8 RCB(e).								
R476	RZM R376,Y	8235	30.93	13.30	169	0.0	0.0	0.9
R482NB	NB R276-43,-89 (C82)	7011	25.36	13.80	161	0.6	0.0	0.1
R484	RZM R384	8744	29.77	14.69	168	0.4	0.0	0.5
F86-31/6	Inc. C31/6, 86263	5751	21.79	13.14	153	0.0	0.0	0.6
R481-43	RZM R381-43	8693	32.43	13.40	164	0.0	0.0	0.4
R481-89	RZM R381-89	8760	31.85	13.74	157	0.0	0.0	0.3
R476-43-#	RZM R376-43-#(C) (C76-43)	8538	29.97	14.26	169	0.0	0.0	0.6
R476-43-14	RZM R376-43-14 (C76-43-14)	8022	29.56	13.59	159	0.4	0.0	0.8
R476-43-15	RZM R376-43-15 (C76-43-15)	8236	27.41	15.04	154	0.0	0.0	0.3
R476-89-5	RZM R376-89-5 (C76-89-5)	8465	26.05	16.27	161	0.0	0.0	0.5
R476-89-18	RZM R376-89-18 (C76-89-18)	6989	24.10	14.55	150	0.0	0.0	0.3
R476-89-#	RZM R376-89-#(C) (C76-89)	8478	30.40	13.98	159	0.0	0.0	1.0
R443	RZM 3284,5,P [R81-89 x (C37 x R22)]	8804	30.35	14.51	169	1.0	0.0	1.5
4284,P	R384 x RZM 3284,5	7959	28.62	13.91	166	0.0	0.0	0.8
4280,P	R380 x RZM 3243 [C37*2 x R22]	8662	31.67	13.71	169	0.0	0.0	0.9
4206-8	R384,R378,R380 x R322Y3%	8745	30.61	14.31	162	0.0	0.0	0.4
Mean		8130.7	28.81	14.14	161.8	0.1	---	0.6
LSD (.05)		698.0	2.41	0.63	14.4	0.7	---	0.6
C.V. (%)		8.7	8.45	4.47	9.0	499.9	---	101.4
F value		11.7**	12.50**	12.18**	1.5NS	1.3NS	---	2.7**

¹R484 = reselection of recombined C76-43 and C76-89 for resistance to rhizomania. R481-43 = C31-43 x C76-43.
R481-89 = C31-89 x C76-89. R443 = rhizomania resistant selection from BC₂ (sugarbeet x Beta maritima). 4284, 4280, & 4206-8 are backcrosses to transfer B.maritima resistance to sugarbeet.

TEST 5095. RHIZOMANIA EVALUATION OF LINES, BLOCK 2-S, SALINAS, CA., 1995

(cont.)

Variety ²	Description	Acre Yield		Sucrose %	Beets/ 100'	Root %	Bolting %	Powdery Mildew Score
		Sugar	Beets					
		Lbs	Tons					
Test 5095-3. 16 x 8 RCB(e).								
2J0179	Betaseed 9-9-94	9582	28.35	16.90	146	0.6	0.0	1.4
R722	Inc. F ₂ (Y54 x B.m.) (C50)	6441	24.52	13.11	163	0.0	6.4	0.9
R422R4(Sp)	RZM R322R4,%	8162	29.56	13.81	166	0.9	1.1	0.6
R422R5(Iso)	RZM R322R4(GSY)	8164	29.73	13.73	165	0.4	0.7	0.6
R422R5%(Iso)	RZM R322R4(%S)	8166	29.14	14.01	166	1.3	0.7	0.4
R422Y3(Sp)	Inc. R322Y3,%	7637	25.78	14.84	154	0.0	0.0	0.3
R436	RZM 3243,P (C79-8)	8248	29.14	14.16	168	0.0	0.0	1.8
R436R2	RZM R336	7814	28.78	13.59	169	0.7	0.0	1.3
R428R2	RZM R328	7072	24.58	14.36	158	0.0	0.0	1.4
R432R2	RZM R332	7170	27.52	12.99	178	0.0	1.4	0.6
R434R2	RZM R334	7294	23.37	15.66	165	0.0	0.0	1.3
R437R2	RZM R337	7479	24.87	15.01	151	0.0	0.0	1.1
4247-9	U86-37 x RZM 3247,3248,3249	6925	24.94	13.84	167	0.0	0.0	1.1
R426	U86-37 x R223,RZM P.I. B.m.	6489	23.26	13.98	164	0.0	0.0	2.1
U86-37	Inc. C37 86443	5314	19.22	13.85	168	0.0	0.0	1.6
R423B	RZM P.I. B.maritima	5636	20.32	13.84	150	0.0	24.3	0.4
Mean		7349.5	25.82	14.23	162.3	0.2	2.2	1.0
LSD (.05)		803.1	2.41	0.75	17.0	1.2	2.8	0.6
C.V. (%)		11.0	9.43	5.35	10.6	493.0	131.9	56.5
F value		13.8**	14.46**	13.23**	1.8*	1.0NS	36.6**	6.7**

²R422R4(Sp) & R422R5(Iso) = cycle 5 selection from R22 (C50) for resistance to rhizomania. R422R5% = 3 cycles of virus yellows selection followed by 1 cycle of rhizomania resistance from R22 (C50). R422Y3 = cycle 3 for VYR. R436 (C79-8) & R436R2 = R22 (C50) rhizomania resistance backcrossed into C37.

R428R2 ≈ C79-4. R432R2 ≈ C79-5.

R434R2 ≈ C79-6. R437R2 ≈ C79-9.

4247-9 = C37 x C79-9,-10,-11. R426 = F₁ (C37 x B.maritima (R423B)).

TEST 5095. RHIZOMANIA EVALUATION OF LINES, BLOCK 2-S, SALINAS, CA., 1995

(cont.)

Variety ³	Description	Acre Yield		Sucrose %	Beets/ 100'	Root Rot %	Bolting %	Powdery Mildew	
		Sugar Lbs	Beets Tons					No.	Score
Test 5095-4. 16 x 8 RCB(e)									
N457	NR-RZM N357,8 (BC ₃ F ₂) (C608)	8187	30.88	13.28	169	0.0	0.0	0.6	0.6
N461	NR-RZM N361,2 (BC ₃ F ₂) (C609)	7353	29.35	12.50	153	0.0	0.0	0.6	0.6
US H11	11-16-94	5490	23.32	11.82	176	0.0	0.0	1.5	1.5
HM-WS PM9	rec'd 4-18-95	5758	21.64	13.29	163	0.0	0.0	0.6	0.6
P402NR	NR P202 (NR from WB 242)	7508	27.20	13.80	166	0.3	0.0	1.3	1.3
PP403	PMR 2211-#(C) (PMR from WB 97)	6487	23.47	13.77	164	0.0	1.9	1.1	1.1
PP404	PMR 2212-#(C) (PMR from WB 242)	5501	19.32	14.20	166	0.0	15.9	0.5	0.5
RR409	CR-RZM R209-#(C)	8834	30.46	14.50	161	0.0	0.0	0.6	0.6
RR410	CR-RZM R210-#(C)	8587	30.56	14.06	163	0.4	0.0	0.6	0.6
RR444	RZM 3287, [2915aa x (C37 x R22)]	7920	29.35	13.51	161	0.4	0.0	0.8	0.8
4287	3918aa x RZM 3287	9226	33.35	13.86	177	0.0	0.0	0.6	0.6
9903	YR-ER-PMR 7903 (A,aa)	7335	27.28	13.48	158	0.0	0.0	0.6	0.6
4915NB	NB 2915 (A,aa)	8909	31.45	14.19	160	0.0	0.0	0.5	0.5
4918(Sp)	RZM 3918aa x A (C918)	8919	31.09	14.34	173	0.0	0.0	0.5	0.5
4911-4M	3911-4m,Maa x A (C911-4)	8963	31.27	14.35	177	0.0	0.0	0.4	0.4
Z430	RZM Z330	9019	30.10	14.99	162	1.2	0.0	0.8	0.8
Mean		7749.7	28.13	13.75	165.5	0.1	1.1	0.7	0.7
LSD (.05)		698.6	2.34	0.61	16.4	0.8	1.9	0.7	0.7
C.V. (%)		9.1	8.39	4.47	10.0	515.8	176.5	94.9	94.9
F value		28.0**	23.81**	12.93**	1.5NS	1.4NS	32.8**	1.6NS	1.6NS

³N457 = C608 & N461 = C609 segregate for combined resistance to cyst nematode and rhizomania. P402NR, P403, & P404 segregate for resistance to cyst nematode and/or powdery mildew. R409 & R410 combine resistance to cercospora leaf spot and rhizomania (see test 6495). 4287 = backcross of C50 (R22) resistance to rhizomania into popn-918.

TEST 7095. PERFORMANCE OF RHIZOMANIA RESISTANT LINES, FIELD C, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 31, 1995
Harvested: November 27, 1995

Variety ¹	Description	Acre Yield		Beets/ 100'	CLS Score	RJAP %	
		Sugar	Beets				
		Lbs	Tons				
US H11	11-16-94	2192	8.76	12.51	176	4.6	76.8
HM3013	9-9-94 (Hilleshog-MH)	2253	8.83	12.71	161	5.0	77.6
R470	RZM R370	5297	19.05	13.91	163	3.8	78.7
R483	RZM R383R	5406	18.93	14.27	165	3.5	78.3
R478NB	NB R278, Y, (C78)	5389	17.93	15.07	168	3.8	77.8
R480NB	NB R280, Y, (C80NB)	5229	17.85	14.66	165	3.8	77.4
R482NB	NB R276-43,-89, (C82)	4170	15.31	13.56	162	4.5	76.9
R484	RZM R384	5174	17.62	14.73	182	4.1	78.0
R443	RZM 3284,5,P	6511	22.95	14.31	173	4.1	76.5
R422R4 (Sp)	RZM R322R4, %	6179	23.80	12.98	172	3.6	73.5
R444	RZM 3287	5728	21.13	13.59	169	2.5	76.0
4918 (Sp)	RZM 3918aa x A, (C918)	4201	14.83	14.15	164	3.3	77.0
4915 (Sp)	RZM 3915aa x A	5047	18.12	13.85	158	2.5	78.1
4911-4M	3911-4m,Maa x A, (C911-4)	5476	18.96	14.41	164	2.9	77.3
R410	CR-RZM R210-#(C)	4631	16.64	13.89	162	1.9	77.6
N457	NR-RZM N357, N358, (C608)	5429	19.87	13.60	150	3.0	77.5
Mean		4894.3	17.54	13.89	165.9	3.5	77.2
LSD (.05)		673.9	2.35	0.63	17.4	0.8	2.2
C.V. (%)		13.9	13.56	4.62	10.6	23.7	2.9
F value		25.1**	24.52**	10.08**	1.5NS	8.2**	2.4**

NOTES: See tests 3395, 1495, 1795, & 5095. Test 3395 under severe rhizomania. Cercospora leaf spot from natural infection; scored on a scale of 0 to 9 where 9 = complete defoliation.

¹ HM3013 = Imperial Valley commercial hybrid used as susceptible check. R484 = reselection for resistance to rhizomania from recombined C76-43 and C76-89. Difference between R482NB and R484 would largely be in gene frequency for Rz where R484 had 2 cycles of selection for resistance to rhizomania and R482NB had one cycle of selection for nonbolting. R443 = F₂(sugarbeet*3 x B.maritima). R444 = F₂(s' sugarbeet*3 x B.maritima). R422R4 = cycle 5 synthetic for resistance to rhizomania from R22(C50). R410 = line with combined resistance to CLS and Rz. N457 = line with combined resistance to cyst nematode and Rz.

TEST 6295. PI EVALUATION OF EGYPTIAN LINES¹ FOR RESISTANCE TO BWYV (VY) AND RHIZOMANIA, SALINAS, CA., 1995

32 entries x 3 replications¹
1-row plots, 12 ft. long

Planted: May 31, 1995
Natural infection to BWYV
Harvested: November 21, 1995

Variety ²	Description ²	Acre Yield		Sucrose %	Bolting %	Powdery Mildew		CLS Score	Beets/ 100'		RJAP %	RZM Resistance ³	
		Sugar Lbs	Beets Tons			Score	Score		No.	100'		DI	%Resist.
US H11	11-16-94	2120	10.76	9.90	0.0	2.0	4.0	4.0	175	75.3	5.16	5.16	5.6
R139C7	RZM R039C6(C39R)	5325	22.06	11.97	0.0	1.0	4.3	4.3	147	76.7	2.98	2.98	86.4
SP7622-0	Inc. SP 6822-0 (8/87) (80466)	2192	10.24	10.67	0.0	2.3	3.3	3.3	169	77.2	4.74	4.74	22.0
Y462	Y-#rrr(C) x RZM R-#(C)	5472	19.58	13.77	0.0	1.7	3.7	3.7	147	77.3	3.41	3.41	72.2
R476-89-18	RZM R376-89-18	3546	13.10	13.40	0.0	2.0	4.7	4.7	158	77.0	4.00	4.00	46.8
R478	RZM R378,Y	5582	19.84	14.00	0.0	1.0	3.7	3.7	169	77.8	3.21	3.21	87.5
R480	RZM R380,Y	4268	15.82	13.43	0.0	1.0	5.0	5.0	153	77.4	3.66	3.66	68.9
R422R4(Sp)	RZM R322R4, %	5928	24.38	12.20	0.0	1.7	3.7	3.7	139	75.9	2.85	2.85	98.0
R423	Inc. R223 (B.m.)	2072	8.30	12.53	5.3	3.7	4.7	4.7	150	71.6	4.14	4.14	47.4
R423B	RZM PI's (B.m.)	1267	5.71	11.00	7.4	2.0	3.7	3.7	147	64.8	3.29	3.29	82.7
R426	U86-37 x R223 (B.m.)	2066	8.69	11.93	0.0	3.7	4.7	4.7	169	74.5	4.48	4.48	28.6
Mean		3621.5	14.41	12.26	1.2	2.0	4.1	4.1	156.8	75.0	3.81	3.81	58.7
LSD (.05)		1864.6	7.16	1.58	8.3	1.7	1.0	1.0	32.2	6.4	0.74	0.74	24.0
C.V. (%)		30.2	29.17	7.56	421.6	50.5	14.8	14.8	12.1	5.0	11.42	11.42	24.0
F value		7.7**	6.70**	6.28**	0.9NS	2.6*	2.6*	2.6*	1.2NS	3.1*	9.04**	9.04**	14.1**

¹Included in this test were 21 PI lines that had been collected in Egypt. This summary includes only 11 check entries analyzed as 11V x 3R RCB. The Egyptian PI's 562581-562604 were removed from the test in mid-July before hard seed was set on the bolted annuals. All of the PI's were very easy bolting, annual lines. They bolted so rapidly that scoring them in the field was difficult. No information on virus yellows reaction was obtained. When removed from the field, the root system was examined and all appeared to be highly susceptible to rhizomania (BNYVV).

²US H11 = rhizomania susceptible check. R423 & R423B = Beta maritima accessions from U.K. previously evaluated for resistance to rhizomania, selected, pooled, and recombined into composite lines. R426 = F₁(C37 x R223 B.m.).

³Roots scored for reaction to rhizomania where 0 = highly resistant and 9 = highly susceptible. % Resistant = (0+1+2+3+4/total)100.

TEST 3595. PERFORMANCE OF SOURCES OF RESISTANCE IN C37 BACKGROUND, BLOCK 2-N, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: March 29, 1995
Harvested: October 3, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100'		Root		RJAP %
		Sugar Lbs	Beets Tons		No.	%	Rot %	Bolting %	
U86-37	Inc. C37	3266	12.47	13.16	121	0.0	0.0	0.0	78.1
R479 (Iso)	C79-1, Rz, RZM R379	4666	17.28	13.65	124	1.5	0.0	0.0	78.1
R424	C79-2, WB41, RZM 3250	4858	17.55	13.91	126	0.0	0.0	0.0	76.1
R425	C79-3, WB42, RZM 3251	4620	16.67	13.96	112	1.1	0.0	0.0	77.3
R428	C79-4, PI07, RZM 3202	4500	16.40	13.73	120	0.5	0.0	0.0	77.7
R432	C79-5, R04, RZM 3201	4340	16.04	13.60	124	1.1	0.0	0.0	80.8
R434	C79-6, R05, RZM 3245	5329	19.40	13.79	118	1.0	0.0	0.0	79.1
R435	C79-7, SES, RZM 3242	5636	19.73	14.34	113	0.0	0.0	0.0	77.5
R436	C79-8, R22, RZM 3243	5639	21.54	13.19	118	5.3	0.0	0.0	78.2
R437	C79-9, WB151, RZM 3247	5404	19.37	14.00	125	0.0	0.0	0.0	76.6
R441	C79-10, WB169, RZM 3248	4797	17.53	13.85	119	0.0	0.0	0.0	77.7
R442	C79-11, WB258, RZM 3249	5148	18.77	13.81	123	1.5	0.0	0.0	78.1
R436R2	R22, RZM R336	6996	26.04	13.55	122	3.3	0.0	0.0	77.5
R422R5 (Iso)	RZM R322R4 (GSY)	7482	27.14	13.80	123	9.4	1.2	0.0	78.2
Rizor	RZ3/1022, 1993	7303	24.05	15.24	118	0.0	0.0	0.0	76.3
US H11	11/16/94	3892	16.78	11.55	124	0.0	0.0	0.0	78.5
Mean		5242.2	19.17	13.70	120.5	1.5	0.1	0.0	77.9
LSD (.05)		893.2	3.34	0.58	16.6	2.8	0.5		2.4
C.V. (%)		17.2	17.55	4.30	13.9	182.1	743.1		3.1
F value		13.7**	10.55**	12.68**	0.5NS	6.6**	2.3**		1.8NS

NOTES: See tests 4995, 6995, & 1795-1. Test 3595 under severe rhizomania. Establishment and growth were variable due to soil-borne problems. Root rot was primarily due to Erwinia from adjacent Erwinia inoculated selection plots.

TEST 4995. PERFORMANCE OF SOURCES OF RESISTANCE IN C37 BACKGROUND UNDER MODERATE RHIZOMANIA, BLOCK 2-S,
SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 30, 1995

Variety	Description ¹	Acre Yield		Sucrose %	Beets/ 100' No.	Root Rot %	Powdery Mildew		RJAP %
		Sugar	Beets				Score	Score	
		Lbs	Tons						
U86-37	Inc. C37	5607	20.69	13.52	163	0.0	1.9	78.1	
R479 (Iso)	C79-1,Rz,RZM R379	6595	25.05	13.11	153	0.0	1.1	76.0	
R424	C79-2,WB41,RZM 3250	8220	28.57	14.39	166	0.0	2.0	77.8	
R425	C79-3,WB42,RZM 3251	6330	22.99	13.77	163	0.0	2.1	76.8	
R428	C79-4,PI07,RZM 3202	6756	23.89	14.14	165	0.0	1.9	78.4	
R432	C79-5,R04,RZM 3201	7196	26.78	13.44	162	0.4	1.9	75.7	
R434	C79-6,R05,RZM 3245	7168	25.21	14.20	159	0.0	1.8	78.1	
R435	C79-7,SES,RZM 3242	8196	29.09	14.09	159	0.0	1.5	77.0	
R436	C79-8,R22,RZM 3243	7705	29.30	13.15	163	0.0	1.5	77.0	
R437	C79-9,WB151,RZM 3247	7916	27.83	14.22	163	0.0	0.9	77.1	
R441	C79-10,WB169,RZM 3248	7509	27.94	13.45	155	0.0	1.1	76.7	
R442	C79-11,WB258,RZM 3249	8051	29.10	13.82	160	0.0	0.9	76.9	
R440-9	RZM 3243 x RZM R40(C)	8091	29.88	13.54	159	0.0	1.4	76.8	
R440H18	3918aa x RZM R40(C)	8278	29.62	13.98	163	0.0	0.8	78.2	
Rizor	RZ3/1022, 1993	8999	29.51	15.25	161	0.4	2.0	77.8	
US H11	11-16-94	5829	23.90	12.21	166	0.0	1.6	78.9	
Mean		7402.9	26.84	13.77	161.2	0.1	1.5	77.3	
LSD (.05)		641.9	2.14	0.55	13.6	0.4	0.7	2.1	
C.V. (%)		8.8	8.03	4.00	8.5	805.6	47.6	2.7	
F value		17.7**	13.95**	11.97**	0.6NS	0.9NS	3.1**	1.5NS	

NOTES: See tests 3595, 6995, 5595, and 1795-1. These tests are an evaluation of the lines C79-1 through C79-11 that were released in 1994. These C79 near-isolines have a C37 background with different sources of resistance to rhizomania. The description gives the C79 release number and the initial source of resistance: Rz = Holly source; WB41, 42, & 151 are Beta maritima accessions from Denmark; PI07 = PI206407, a sugarbeet line from Turkey but the sole resistant plant had Swiss chard like traits; R04 = weed beet source from Italy; R05 = sugarbeet source from Italy; SES = resistance from 'Rima'; R22 = C50 = sugarbeet x B.maritima collection; WB169 and 258 = B.maritima accessions from Italy.

¹R40(C) is a polycross composite of C79-#'s.

TEST 6995. PERFORMANCE OF SOURCES OF RESISTANCE IN C37 BACKGROUND, FIELD C, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 31, 1995
Harvested: November 20, 1995

Variety	Description¹	Acre Yield		Sucrose %	Beets/ 100'	CLS Score	RJAP %
		Sugar	Beets				
		Lbs	Tons				
U86-37	Inc. C37	2794	10.01	13.94	188	4.0	77.5
R479(Iso)	C79- 1, Rz, RZM R379	3926	13.63	14.40	171	3.6	78.6
R424	C79- 2, WB41, RZM 3250	3701	13.19	14.04	181	3.6	78.2
R425	C79- 3, WB42, RZM 3251	3740	13.20	14.18	176	3.8	77.1
R428	C79- 4, PI07, RZM 3202	3357	11.84	14.20	186	3.4	80.8
R432	C79- 5, R04, RZM 3201	3937	13.77	14.24	183	3.4	79.6
R434	C79- 6, R05, RZM 3245	4325	14.54	14.90	176	3.3	80.3
R435	C79- 7, SES, RZM 3242	5028	16.43	15.27	173	4.0	81.0
R436	C79- 8, R22, RZM 3243	5123	19.93	12.93	168	2.6	75.9
R437	C79- 9, WB151, RZM 3247	4110	14.23	14.49	180	4.3	77.6
R441	C79-10, WB169, RZM 3248	4562	15.81	14.45	179	3.9	78.3
R442	C79-11, WB258, RZM 3249	4633	16.33	14.24	168	3.9	79.8
R436R2	R22, RZM R336	6099	22.74	13.43	181	2.6	76.9
R422R5(Iso)	RZM R322R4 (GSY)	6485	23.63	13.70	166	3.8	77.2
Rizor	RZ3/1022, 1993	6365	20.71	15.35	174	4.9	78.5
US H11	11-16-94	2243	9.02	12.51	194	4.3	76.1
Mean		4401.8	15.56	14.14	177.7	3.7	78.3
LSD (.05)		702.3	2.56	0.65	14.8	0.9	2.8
C.V. (%)		16.1	16.58	4.64	8.4	23.7	3.6
F value		23.2**	21.78**	10.55**	2.3*	3.4**	2.6**

NOTES: See tests 4995, 3595, 5595, & 1795-1.

¹See test 4995 for descriptions of C79-#'s. R436R2 ≈ C79-8 but with one fewer backcrosses to C37 and one additional cycle of selection for resistance to rhizomania. R422R5 = cycle 5 synthetic from C50(R22) source of Y54 x B.maritima collection.

TEST 5595. RHIZOMANIA EVALUATION OF SOURCES OF RESISTANCE IN POLY-CROSS LINES, BLOCK 2-S, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 4, 1995
Harvested: October 20, 1995

Variety	Description ¹	Acre Yield		Sucrose %	Beets/ 100'	Root %	Bolting %
		Sugar Lbs	Beets Tons				
U86-37	C37, Inc. C37 (86443)	6250	22.95	13.63	168	0.0	0.0
R479 (Iso)	Rz, RZM R379 (C79-1)	7980	28.85	13.81	157	0.0	0.0
R440-1	C37, U86-37 x RZM R40(C)	7572	26.62	14.21	154	0.0	0.0
R440-2	Rz, RZM R337-# x RZM R40(C)	8728	30.14	14.49	156	0.3	0.8
R440-3	R04, RZM 3201 x RZM R40(C)	8203	30.14	13.61	162	0.4	0.0
R440-5	PI07, RZM 3202 x RZM R40(C)	8329	28.21	14.77	163	0.0	0.0
R440-7	R05, RZM 3245 x RZM R40(C)	7813	26.78	14.63	157	0.0	0.0
R440-9	R22, RZM 3243 x RZM R40(C)	8514	30.25	14.09	164	0.0	0.0
R440-11	WB151, RZM 3247 x RZM R40(C)	8215	28.99	14.18	163	0.0	0.0
R440-13	SES, RZM 3242 x RZM R40(C)	8626	29.77	14.54	147	0.0	0.4
R440-15	WB169, RZM 3248 x RZM R40(C)	8086	28.71	14.09	157	0.3	0.0
R440-17	WB258, RZM 3249 x RZM R40(C)	9019	31.98	14.10	162	0.0	0.4
R440-19	WB41, RZM 3250 x RZM R40(C)	8003	28.30	14.18	165	0.0	0.0
R440-22	WB42, RZM 3251P x RZM R40(C)	8143	27.88	14.55	159	0.4	0.0
R440H94	Rzmm, 3894aa x RZM R40(C)	9607	33.50	14.34	167	0.0	0.0
R479H94	Rzmm, 3894aa x R379 (C79-1)	8691	31.51	13.76	150	0.0	0.0
Mean		8236.2	29.04	14.19	159.3	0.1	0.1
LSD (.05)		877.4	2.83	0.63	16.8	0.5	0.6
C.V. (%)		10.8	9.84	4.47	10.6	577.1	557.2
F value		5.4**	5.87**	2.52**	1.0NS	0.8NS	1.3NS

NOTES: See tests 4995, 3595, 6995, 5595, & 1795-1. Test 5596 under moderate rhizomania conditions.

¹R40(C) = composite of mother roots selected for resistance to rhizomania combined to form a polycross of all sources of resistance in a C37 background. R440-# = line from individual source crossed to composited mother roots from all sources. The first column under the description identifies the source of resistance of the female (seed bearing) line.

TEST 1395. PERFORMANCE OF POPULATIONS WITH BETA MARITIMA GERMPASM UNDER VIRUS YELLOWS CONDITIONS,
SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 21 ft. long

Planted: April 12, 1995
Harvested: September 28, 1995
BYV/BWV Inoc.: June 8, 1995

Variety ¹	Description ¹	Acre Yield		Sucrose %	Root Rot %	Beets/ 100' No.	Powdery Mildew		Virus Yellows Score ³	Bolting		RJAP %
		Sugar Lbs	Beets Tons				Score ²			Score ²		
4454	Comm. check, Betaseed	6894	25.34	13.59	0.0	153	5.2		6.2	0.0		78.7
KW6770	Susc., high %S check	4687	17.16	13.64	0.4	155	6.1		6.4	0.0		79.0
R482NB	NB R276-43,-89,(C82)	5785	21.93	13.19	0.0	126	4.6		5.8	0.0		79.7
R443	RZM 3284,5,P,[(R281-89 x (C37 x R22))]	5824	22.69	12.82	0.0	152	5.7		5.8	0.0		77.7
4915(sp)	RZM 3915aa x A	6693	25.71	13.01	0.0	156	4.5		5.7	0.0		78.9
R444	RZM 3287,[2915aa x (C37 x R22)]	5227	21.19	12.34	0.8	149	5.3		5.8	0.0		77.0
R422Y3(sp)	Inc. R322Y3,%	6256	22.85	13.69	0.0	150	4.7		5.7	0.0		77.6
R422Y3H15	3915aa x R322Y3,%	6993	26.18	13.34	0.0	158	4.8		5.6	0.0		78.4
R422R4	RZM R322R4,%	4870	20.43	11.93	0.0	154	6.2		5.9	3.0		75.3
R422R4H15	3915aa x RZM R322R4,%	6268	24.49	12.80	0.0	149	5.7		5.9	0.4		77.9
R440-9	RZM 3243 x RZM R40(C)	5011	20.14	12.44	0.0	146	5.8		5.8	0.0		76.4
R440H18	3918aa x RZM R40(C)	6256	24.34	12.84	0.0	155	5.0		5.8	0.0		78.3
Mean		5896.8	22.70	12.97	0.1	150.3	5.3		5.9	0.3		77.9
LSD (.05)		660.8	2.20	0.50	0.7	14.2	0.4		0.2	1.5		2.7
C.V. (%)		11.3	9.73	3.88	740.0	9.5	7.4		2.8	546.2		3.5
F value		11.6**	11.84**	9.69**	0.9NS	2.8**	18.0**		13.1**	2.6**		1.6NS

¹R422Y3 = cycle 3 synthetic from C50(R22) selected for resistance to virus yellows. R422R4 = cycle 5 from R22 selected for resistance to rhizomania.

²Powdery mildew controlled until late in season with Bayleton. Reactions scored on a scale of 0 to 9 where 9 = highly infected.

³Virus yellows scored from 0 to 9 on basis of canopy yellowing.

TEST 3295. PERFORMANCE OF R22 SYNTHETICS AND HYBRIDS UNDER SEVERE RHIZOMANIA, BLOCK 2-N, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: March 29, 1995
Harvested: October 2, 1995

Variety	Description ¹	Acre Yield		Sucrose %	Beets/ 100'	Root %	Bolting %	RJAP %
		Sugar Lbs	Beets Tons					
US H11	11-1-94	5289	21.03	12.66	132	0.0	0.0	81.6
4581	3072 (2-16-94)	7699	26.08	14.89	125	0.0	0.0	79.2
4918 (Sp)	RZM 3918aa x A, (C918)	5736	20.12	14.41	122	0.0	0.4	79.4
R422R4 (Sp)	RZM R322R4, %	7650	28.03	13.69	122	2.7	2.9	75.7
R422R4H15	3915aa x RZM R322R4, %	8799	32.09	13.84	128	0.0	0.5	77.1
R422R4H17	5747aa x RZM R322R4, %	8468	31.83	13.40	124	0.5	0.5	77.3
R422R4H50	F92-790-15CMS x RZM R322R4, %	8863	32.85	13.56	128	2.4	0.0	76.9
4918H50	F92-790-15CMS x RZM 3918	7232	26.33	13.89	127	0.0	0.0	77.5
R422Y3 (Sp)	Inc. R322Y3, %	6478	22.68	14.34	118	1.1	0.0	78.0
R422Y3H50	F92-790-15CMS x R322Y3, %	7290	25.82	14.15	123	1.0	0.0	79.6
R422Y3H15	3915aa x R322Y3, %	7834	27.12	14.50	121	0.0	0.5	79.2
R440H50	F92-790-15CMS x RZM R40(C)	6989	25.00	14.09	124	0.0	0.0	81.5
R440-9	RZM 3243 x RZM R40(C)	6966	24.92	14.05	124	0.0	0.0	78.6
R440H18	3918aa x RZM R40(C)	5514	19.45	14.25	125	0.0	0.0	79.9
R436R2	RZM R336	7475	28.20	13.32	129	4.2	0.0	76.0
R436R2H50	F92-790-15CMS x RZM R336	7791	28.18	13.89	126	4.5	0.0	79.6
Mean		7254.6	26.23	13.93	124.7	1.0	0.3	78.6
LSD (.05)		1111.6	3.91	0.60	12.1	2.4	1.2	2.9
C.V. (%)		15.5	15.05	4.36	9.8	232.5	397.8	3.8
F value		7.4**	8.47**	6.21**	0.7NS	3.5**	3.0**	2.8**

NOTES: See tests 1795-2, 4395, 5095-3, 1395, and 6895.

¹See tests 4395 & 6895 for descriptions. R436R2 = 2RZM F₃ (C37 x R22). R436R2H50 = monogerm, rzm susc. CMS x R36, i.e., a USDA experimental hybrid with approximately 12.5% of the germplasm and resistance to rhizomania from B.maritima.

TEST 4395. PERFORMANCE OF R22 SYNTHETICS AND HYBRIDS UNDER MODERATE RHIZOMANIA, BLOCK 2-S,
SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: November 3, 1995

Variety¹	Description¹	Acre Yield		Beets/ 100'	Root Rot	Bolting %	Powdery Mildew		RJAP %
		Sugar	Beets				Sucrose %	Score	
		Lbs	Tons						
US H11	11-16-94	5058	22.17	11.35	163	0.0	0.0	3.0	77.1
4581	2-16-94, Betaseed	9358	33.45	14.01	158	0.0	0.0	1.9	78.7
4918 (Sp)	RZM 3918aa x A, (C918)	8368	30.40	13.73	160	0.0	0.0	2.5	77.8
R422R4 (Sp)	RZM R322R4, %	8025	32.23	12.50	157	1.4	2.1	2.4	74.0
R422R4H15	3915aa x RZM R322R4, %	9353	36.13	12.95	160	0.4	0.0	1.9	76.9
R422R4H17	5747aa x RZM R322R4, %	8432	34.66	12.16	152	0.0	0.0	2.7	75.6
R422R4H50	F92-790-15CMS x RZM R322R4, %	8916	35.03	12.74	161	0.4	0.0	2.0	74.9
R444	RZM 3287, [2915aa x (C37 x R22)]	7557	30.09	12.55	149	0.0	0.0	2.1	75.9
4918H50	F92-790-15CMS x RZM 3918	8730	33.03	13.23	158	0.4	0.0	2.1	77.7
R422Y3 (Sp)	Inc. R322Y3, %	7303	27.25	13.40	151	0.0	0.0	2.3	76.4
R422Y3H50	F92-790-15CMS x R322Y3, %	8391	31.19	13.48	159	0.0	0.0	2.4	79.2
R422Y3H15	3915aa x R322Y3, %	8481	30.52	13.93	160	0.4	0.0	2.1	75.8
R436R2	RZM R336	8007	32.36	12.35	152	1.7	0.0	2.7	74.2
R436R2H50	F92-790-15CMS x RZM R336	8367	32.24	12.96	161	0.8	0.0	2.3	76.2
R443	RZM 3284, 5, P, [R81-89 x (C37 x R22)]	8588	31.88	13.49	157	0.8	0.0	2.4	77.1
R484	RZM R384	7649	27.67	13.80	146	0.0	0.0	2.1	77.9
Mean		8161.5	31.27	13.04	156.5	0.4	0.1	2.3	76.6
LSD (.05)		768.1	2.77	0.55	16.1	1.2	0.7	0.6	2.0
C.V. (%)		9.5	8.93	4.23	10.4	306.8	501.7	25.0	2.7
F value		13.6**	11.98**	14.13**	0.8NS	1.6NS	5.1**	2.3**	4.4**

NOTES: Also see tests 1795-2, 5095-3, 1395, 3295, & 6895.

¹R422R4 = cycle 5 synthetic from C50(R22) selected for resistance to rhizomania. R422Y3 = cycle 3 synthetic selected for resistance to virus yellows (BYV/BWV). H15 hybrids = R22 synthetic as male crossed to population with R₂ (Holly) factor for resistance. H50 = rhizomania susceptible mmCMS x R22 synthetics. H17 = rhizomania susceptible population as female. R436R2 ≈ C79-8, i.e., C37 with resistance from B.maritima. R444 ≈ F₂ (sugarbeet*2 x R22). R443 ≈ F₂(sugarbeet*2 x R22). R484 = rhizomania resistant selection from C76-43 x C76-89.

TEST 6895. PERFORMANCE OF R22 SYNTHETICS AND HYBRIDS, FIELD C, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 31, 1995
Harvested: November 27, 1995

Variety ¹	Description ¹	Acre Yield		Sucrose %	Beets/ 100'	CLS Score ²	RJAP %
		Sugar Lbs	Beets Tons				
US H11	11-1-94	3151	11.45	13.74	171	3.6	75.4
4581	3072 (2-16-94), Betaseed	6611	20.43	16.20	173	4.1	81.4
4918(Sp)	RZM 3918aa x A, (C918)	4841	15.47	15.64	166	3.3	78.7
R422R5	RZM R322R4 (GSY)	6380	22.52	14.18	171	3.6	76.8
R422R5%	RZM R322R4 (%)	6785	24.30	13.96	163	3.9	75.4
R422R4(Sp)	RZM R322R4, %	5995	21.73	13.80	156	4.0	75.7
R422R4H15	3915aa x RZM R322R4, %	7191	24.28	14.79	159	3.6	78.1
R422R4H17	5747aa x RZM R322R4, %	7156	25.86	13.84	163	4.1	78.1
R422R4H50	F92-790-15CMS x RZM R322R4, %	7133	24.22	14.69	167	4.1	79.3
R422Y3 (Sp)	Inc. R322Y3, %	5019	16.54	15.11	162	4.3	77.0
R422Y3H15	3915aa x R322Y3, %	5752	18.52	15.55	167	4.1	78.6
R422Y3H50	F92-790-15CMS x R322Y3, %	4822	16.26	14.82	166	3.6	77.8
R426	U86-37rr x R223 (RZM P.I.)	3061	11.06	13.88	170	3.8	75.0
R436R2	RZM R336	6094	21.31	14.36	158	4.5	77.2
R440-9	RZM 3243 x RZM R40(C)	5738	19.95	14.44	156	4.0	78.7
R443	RZM 3284,5,5P	5840	19.55	14.82	163	4.4	78.6
Mean		5723.2	19.59	14.61	164.4	3.9	77.6
LSD (.05)		760.5	2.48	0.68	17.0	0.9	2.4
C.V. (%)		13.4	12.78	4.71	10.4	24.0	3.1
F value		22.2**	25.46**	9.12**	0.8NS	1.0NS	3.9**

NOTES: See tests 1795-2, 5095-3, 1395, 3295, and 4395. Test 6895 under severe rhizomania.

¹See test 4395 for more complete descriptions. R422R5, R422R5%, and R422R4(Sp) = cycle 5 synthetics from C50(R22) for resistance to rhizomania. R422Y3 = cycle 3 synthetic for resistance to virus yellows. R426 = F₁(C37 x B.m.) where R426 is a mixture of C37 sibs and F₁'s to B.m. In future, true F₁'s will be identified by genetic markers of hypocotyl color and resistance to rhizomania. R440-9 ≈ C79-8 x polycross of all sources of resistance in C37 background.

²Cercospora leaf spot from natural infection. Score on a scale of 0 to 9 where 9 = complete defoliation.

TEST 1295. EVALUATION/SELECTION FOR RESISTANCE TO POWDERY MILDEW & YIELD, SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 21 ft. long

Planted: April 12, 1995
Harvested: September 29, 1995

Variety ¹	Description ¹	Acre Yield		Sucrose %	Bolting %	Beets 100' No.	Powdery Mildew Score ²	RJAP %
		Sugar	Beets					
		Lbs	Tons					
US H11	11-16-94	8823	28.51	15.46	0.0	164	5.8	86.0
HM-WS-PM-9	HM-PM9 (1991 seed)	8954	27.45	16.31	0.0	155	5.0	85.6
Y039	Inc. Y939, (C39)	8302	25.50	16.24	0.0	136	4.3	85.6
U86-37	Inc. C37 (86443)	7251	23.02	15.76	0.0	159	5.7	87.4
P401	PMR P201	9477	30.14	15.73	1.6	152	4.5	84.5
P403	PMR 2211-#(C)	8439	27.08	15.56	5.3	158	4.9	86.4
P402	PMR P202	9135	29.40	15.52	0.4	150	4.3	86.1
P404	PMR 2212-#(C)	7577	25.02	15.14	22.1	152	4.2	85.1
P402NR	NR P202	10080	32.15	15.70	0.0	161	4.9	85.6
P405	PMR 2219-#(C)	6998	22.33	15.68	0.0	158	4.9	85.1
4918(Sp)	RZM 3918aa x A, (C918)	9420	30.15	15.61	0.0	140	4.4	84.6
R476-43-15	RZM R376-43-15, (C76-43-15)	8179	24.66	16.60	0.0	139	4.1	86.5
Mean		8552.9	27.12	15.78	2.5	151.9	4.7	85.7
LSD (.05)		862.8	2.58	0.41	3.5	11.0	0.3	2.0
C.V. (%)		10.1	9.56	2.60	142.1	7.3	7.1	2.3
F value		9.5**	11.22**	7.95**	26.8**	5.5**	21.1**	1.4NS

NOTES: See test 6195. Test 1295 was not infected with rhizomania.

¹P# lines have high resistance to powdery mildew transferred from WB97 and WB242 Beta maritima accessions into C37 background. P401 = BC₂F₃(C37*3 x WB97, WB242). P403 = BC₃F₂(C37*4 x WB97). P402 = BC₂F₃{popn-747aa x (C37*2 x WB97, WB242)}. P404 = BC₃F₂(C37*4 x WB242). P402NR = BC₂F₃ selected for resistance to SBCN from WB242. P405 = BC₃F₂{C309aa x (C37*3 x WB97 WB242)}. WP97 and 242 are susceptible to rhizomania.

²For test 1295, powdery mildew was not controlled. Score is a mean of five weekly ratings on a plot basis. These plot scores do not take into account, individual plant segregation within plots. For P401, P403, P402, P404, P402NR, and P405, individual plants occurred that were highly resistant to PM. These lines thus showed discrete segregation for reaction to powdery mildew. From test 6195, individual, highly resistant plants were saved and will be used in genetic analysis of inheritance of resistance and to transfer resistance to sugarbeet. Also, mother roots were selected from P402NR for resistance to SBCN derived from WB242.

TEST 6195. EVALUATION/SELECTION FOR RESISTANCE TO POWDERY MILDEW, FIELD C, SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 12 ft. long

Planted: May 31, 1995
Harvested: November 27, 1995

Variety ¹	Description ¹	Acre Yield		Beets/ 100'	Bolting %	Powdery Mildew		CLS Score ³	RJAP %
		Sugar Lbs	Beets Tons			Sucrose %	Score ²		
US H11	11-16-94	5748	22.42	162	0.0	3.8	4.0	79.8	
HM-WS-PM9	4-18-95	5752	20.02	166	0.0	2.0	4.3	80.8	
R476-43-15	RZM R376-43-15, (C76-43-15)	9869	31.17	145	0.0	1.4	3.4	80.8	
U86-37	Inc. C37 (86443)	5208	18.72	159	0.0	3.6	3.6	78.4	
P401	PMR P201	7465	25.10	166	0.0	1.6	3.0	79.6	
P403	PMR 2211-# (C)	6721	23.80	155	0.0	3.5	4.0	75.7	
P402	PMR P202	6586	25.39	152	1.3	1.9	4.5	75.9	
P404	PMR 2212-# (C)	7016	23.92	166	6.5	2.1	3.5	78.5	
P402NR ⁴	NR P202	7388	26.70	142	0.0	2.5	4.0	78.6	
P405	PMR 2219-# (C)	6355	21.44	154	0.0	2.4	4.4	77.5	
4918 (Sp)	RZM 3918aa x A, (C918)	9265	32.48	153	0.0	2.0	3.3	79.1	
R039C5	Inc. R939C5, (C39R)	10451	35.25	144	0.0	1.0	3.3	79.6	
Mean		7318.6	25.53	155.3	0.6	2.3	3.8	78.7	
LSD (.05)		1169.2	3.89	19.1	2.1	1.0	0.7	4.5	
C.V. (%)		16.1	15.29	12.3	329.1	42.4	18.1	5.7	
F value		16.6**	13.59**	1.7NS	6.3**	6.6**	4.2**	1.1NS	

NOTES: See test 1295. Test 6195 was grown under moderate rhizomania conditions.

¹See test 1295.

²PM scores from a single rating on 11-14-95 on a plot basis.

³Cercospora leaf spot scored 11-15-95 on a scale of 0 to 9 where 9 = complete defoliation (also see test 6495).

⁴P402NR = selection for BCNR derived from WB242. In an adjacent selection block, P402NR was scored 64 plants without cysts/50 plants with cysts. In comparison, US H11 was rated 5/88. P402NR and the other P#d lines are susceptible to rhizomania.

TEST 6495. COMBINED RESISTANCE TO RHIZOMANIA AND CERCOSPORA LEAF SPOT, SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 12 ft. long

Planted: May 31, 1995
Harvested: November 28, 1995
Inoc. C.b.: September 6, 1995

Variety ¹	Description ¹	Acre Yield		Beets/ 100'	Sucrose %	Powdery Mildew		CLS Score ²	RJAP %
		Sugar Lbs	Beets Tons			No.	Score		
R434R2	RZM R334 (= C79-6)	5409	17.38	130	15.56	2.9	2.9	4.1	76.4
R409	CR-RZM R209-#(C)	7264	25.91	140	14.04	2.1	2.1	3.0	77.1
R409R2	RZM R309	7765	28.50	137	13.61	2.6	2.6	3.8	78.1
R410	CR-RZM R210-#(C)	7728	27.43	119	14.19	1.5	1.5	3.5	78.3
R410R2	RZM R310	7597	27.23	133	13.99	1.6	1.6	4.0	77.2
R107	RZM R007	5974	20.03	131	14.90	2.9	2.9	3.8	79.5
R105	RZM R005	5205	16.29	141	15.98	2.9	2.9	3.9	78.0
Rizor	RZ3/1022, 1993	7085	21.79	144	16.34	2.0	2.0	6.1	77.5
R108	RZM R008	6215	21.88	136	14.20	1.9	1.9	3.6	77.1
R106	RZM R006	4772	15.59	142	15.36	2.5	2.5	3.3	77.5
4915	RZM 3915aa x A	6558	23.92	143	13.73	1.0	1.0	3.8	77.8
US H11	11-9-94	3118	12.72	148	12.41	2.0	2.0	4.9	76.5
Mean		6224.3	21.56	137.0	14.53	2.2	2.2	4.0	77.6
LSD (.05)		899.4	2.92	19.1	0.80	1.0	1.0	0.8	2.9
C.V. (%)		14.5	13.60	14.0	5.55	46.4	46.4	19.4	3.7
F value		19.6**	25.46**	1.3NS	15.64**	3.0**	3.0**	9.1**	0.7NS

NOTES: See test 6395 submitted by Lee Panella in the Report from Fort Collins. See tests 6895 through 7295 for reaction of breeding lines and hybrids to cercospora leaf spot.

Fields B & C at Salinas have been in rhizomania trials since 1984. From inoculum of *Cercospora beticola* carried over in the soil, a moderate level of natural leaf spot infection occurs in the late summer and fall. In addition to this natural infection, in 1995, tests 6395 & 6495 were inoculated (September 6, 1995). One of the breeding objectives at Salinas is to combine resistance to *Cercospora* with resistance to rhizomania, curly top, bolting, virus yellows, Erwinia, powdery mildew, etc. In 1995, mother roots with dual resistance to rhizomania and *Cercospora* were selected from lines R409, R409R2, R410, and R410R2 within test 6495. These will be used for breeding purposes in 1996.

¹R105 & R106 = reselections for resistance to rhizomania from CR Italian sugarbeet accessions. R107 & R108 = CR-RZM selections from crosses between popn-915 and R105 & R106 types. R409 & R410 = CR-RZM selections from backcrosses of R107 & R108 to popn-915. R409R2 & R410R2 = cycle 2 RZM selections from backcrosses. 4915 = popn-915 = MM,S^f,A:aa,Rz population.

²Cercospora leaf spot scored 11-20-95 on a scale of 0 to 9 where 9 = complete defoliation.

DAVIS 1995-1. EVALUATION OF ADVANCED EXPERIMENTAL HYBRIDS FOR VIRUS YELLOWS, DAVIS, CA., 1995

12 varieties x 2 virus trtmts x 6 reps (Split-plot)
1-row plots, 29 ft. long, 30" wide.

Planted: May , 1995
Harvested: October 11-12, 1995

Variety	Description	Acre Yield ¹		Beets tons	Acre Yield ²		Beets tons	Acre Yield ³		Beets tons	Beets tons	Sucrose ³ %
		Sugar lbs	Sucrose ¹ %		Sugar lbs	Sucrose ² %		Sugar lbs	Sucrose ³ %			
4454	Commercial check, Betaseed	5954	20.80	14.20	3983	14.53	13.72	7926	27.07	14.68		
KW6770	High %S, susc. check	5433	18.02	14.83	3206	11.41	14.10	7659	24.63	15.56		
R481-43H50	F92-790-15CMS x RZM R381-43	5747	19.95	14.26	3918	14.46	13.58	7577	25.45	14.94		
R481-89H50	F92-790-15CMS x RZM R381-89	6135	22.48	13.66	4309	15.87	13.60	7961	29.08	13.72		
R484H50	F92-790-15CMS x RZM R384	5772	20.53	13.94	4186	15.63	13.40	7358	25.44	14.48		
R470H50	F92-790-15CMS x RZM R370	5699	20.28	13.99	3608	13.09	13.80	7789	27.47	14.18		
R480H50	F92-790-15CMS x RZM R380,Y	5771	20.63	13.91	4016	15.00	13.46	7527	26.26	14.36		
R480-45H50	F92-790-15CMS x R280-45	5376	18.92	14.10	3471	12.71	13.68	7282	25.13	14.52		
4918H50	F92-790-15CMS x RZM 3918	5477	19.59	13.86	3607	13.51	13.38	7348	25.67	14.34		
3913-70H50	F92-790-15CMS x RZM 3913-70	5763	20.51	13.97	3846	14.17	13.60	7680	26.86	14.34		
R422Y3H50	F92-790-15CMS x R322Y3, %	5375	18.67	14.34	3976	14.32	13.94	6775	23.03	14.74		
R422R4H50	F92-790-15CMS x RZM R322R4, %	4899	18.27	13.34	3405	13.13	13.00	6393	23.41	13.68		
Mean		5616.8	19.89	14.03	3794.1	13.98	13.61	7439.4	25.79	14.46		
LSD (.05)		413.4	1.40	0.30	584.6	1.98	0.42	584.6	1.98	0.42		
C.V. (%)		9.1	8.67	2.61	9.1	8.67	2.61	9.1	8.67	2.61		
F value - variety		4.1**	5.40**	10.11**								
F value - virus		**	**	**								
F value - variety x virus		*	*	**								

¹Variety means over both virus treatments analyzed as split-plot.

²Variety means for inoculated treatment. BYV/BWV inoculated June 15, 1994.

³Variety means for noninoculated treatment.

Replication 1 was deleted.

NOTES: Grown by Dr. Steve Kaffka and Gary Peterson, U.C. Davis. Sugar and impurity analyses by Spreckels Sugar, Woodland, CA.

DAVIS 1995-1. EVALUATION OF ADVANCED EXPERIMENTAL HYBRIDS FOR VIRUS YELLOWS, DAVIS, CA., 1995

(cont.)

Variety	Recover.		Recover.		Recover.		Known		Sodium		Potassium		NH ₂ -N		Impur.	
	Sugar	lbs/a	Sugar	lbs/t	Sugar	%	Sugar	lbs/a	ppm	ppm	ppm	ppm	ppm	ppm	Value	Value
4454	4865		231		81.4		1089		523		2299		1052		17571	
KW6770	4466		244		82.1		967		524		2155		1093		17603	
R481-43H50	4586		226		79.2		1161		440		2062		1360		19616	
R481-89H50	4929		219		80.1		1206		509		2142		1153		18086	
R484H50	4652		224		80.5		1120		451		2095		1189		18110	
R470H50	4542		222		79.4		1156		490		2155		1265		19120	
R480H50	4649		224		80.3		1122		437		2211		1167		18148	
R480-45H50	4363		228		80.7		1013		499		2142		1147		17995	
4918H50	4329		218		78.5		1148		464		2250		1322		19803	
3913-70H50	4596		222		79.5		1166		486		2175		1248		19001	
R422Y3H50	4212		225		78.3		1163		441		2123		1452		20643	
R422R4H50	3846		208		78.1		1052		488		2111		1313		19458	
Mean	4502.9		224.3		79.8		1113.9		479.4		2160.0		1230.0		18762.8	
LSD (.05)	359.6		7.8		1.6		114.0		54.6		139.6		129.4		1367.0	
C.V. (%)	9.8		4.3		2.5		12.6		14.0		8.0		13.0		9.0	
F value - variety	4.4**		7.7NS		4.1**		1.1NS		2.3*		1.5NS		5.4**		3.4**	
Inoc mean	2996.5		215.1		79.0		797.7		495.9		2182.1		1241.0		18980.7	
Non-inoc mean	6009.4		233.5		80.7		1430.0		462.9		2137.9		1218.9		18545.0	
F value - virus	**		**		*		**		*		NS		NS		NS	
F value - v x v	*		NS		NS		NS		*		*		NS		NS	

TEST 1695. PERFORMANCE OF MONOGERM POPULATIONS AND BREEDING LINES, SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 21 ft. long

Planted: April 12, 1995
Harvested: September 27, 1995

Variety ¹	Description ¹	Acre Yield		Sucrose %	Root Rot %	Beets 100' No.	Powdery Mildew		RJAP
		Sugar	Beets				%	%	
		Lbs	Tons						
4911-4M	3911-4m, Maa x A (C911-4)	8826	33.15	13.29	0.0	157	4.1	77.5	
4911-4H25	5816aa x 3911-4m	9039	32.83	13.77	0.0	159	5.4	76.5	
4911-4H90	0790aa x 3911-4m	9835	35.84	13.73	0.0	168	4.5	77.1	
4831	3911-4m, mmaa x mm, O-T(C)	9659	35.16	13.71	0.0	158	4.8	77.1	
4833	RZM 3867m(Sp)aa x mm, O-T(C)	8407	32.94	12.75	0.0	164	5.2	77.0	
4895	RZM 3280, ..., 3282, (2867aa x 0790)	6599	26.02	12.71	0.0	154	5.3	74.7	
4893	RZM 3893, (popn-800'saa x mm, O-T)	7901	30.25	13.05	1.2	165	5.3	76.9	
4890m	RZM 3890mmaa x A (C890)	9145	33.46	13.65	0.0	162	4.9	77.8	
4859m	RZM 3859mmaa x A (C859)	7346	28.03	13.10	0.0	146	5.3	76.4	
4865m	RZM 3865mmaa x A	7609	28.72	13.24	0.4	156	5.5	77.2	
4865NB	NB 2865m (Sp) (%S) (A,aa)	6044	23.38	12.94	0.0	161	5.2	75.4	
4894	RZM 3894m (A,aa)	7608	29.72	12.79	0.7	164	5.5	76.1	
Mean		8168.3	30.79	13.23	0.2	159.6	5.1	76.7	
LSD (.05)		828.2	2.71	0.49	1.0	12.1	0.3	1.6	
C.V. (%)		10.2	8.83	3.71	502.2	7.6	6.0	2.1	
F value		16.3**	15.44**	5.40**	1.3NS	1.9NS	16.3**	2.6**	

NOTES: See test 4195 for performance under rhizomania.

¹Test of populations that are monogerm or segregate for monogerm. Being developed as potential source populations for monogerm, O-type lines with combined disease resistance, including resistance to rhizomania. 3911-4 = half-sib selection from popn-911 that segregates for monogerm and has resistance or tolerance to virus yellows, rhizomania, powdery mildew, Erwinia, bolting, and curly top. 5816 = line similar to C309. 0790 = C790. mm, O-T(C) = composite of monogerm, O-type, curly top resistant lines, e.g., C718, C562, C546, C762-17, etc. 3865 = population similar to C310.

TEST 4195. PERFORMANCE OF MONOGERM SOURCES UNDER MODERATE RHIZOMANIA, BLOCK 2-S, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: November 2, 1995

Variety ¹	Description ¹	Acre Yield		Sucrose %	Beets/ 100'	Powdery Mildew		Root	
		Sugar Lbs	Beets Tons			Mean	Rot %	RJAP %	
0790	8790-S ₁ (C)aa x A (C790)	5416	21.37	12.71	157	2.0	0.0	79.6	
4890m	RZM 3890mmaa x A (C890)	6468	24.74	13.09	154	2.5	1.4	80.0	
0787	BYR-ER-PMR 8787	4673	19.43	12.01	154	1.8	0.0	78.1	
4894	RZM 3894m (A,aa)	6539	26.47	12.38	152	2.9	0.4	76.2	
4911-4M	3911-4m,Maa x A (C911-4)	7601	27.41	13.82	147	1.6	0.0	77.6	
4911-4H25	5816aa x 3911-4m	7993	27.41	14.57	161	2.7	0.0	78.8	
4911-4H90	0790aa x 3911-4m	8361	29.98	13.93	159	1.9	0.8	79.0	
4831	3911-4mmaa x mm,O-T(C)	8525	31.77	13.41	141	2.0	0.0	78.8	
4832	2915H90,...,2890H15aa x mm,O-T(C)	7350	27.46	13.43	156	2.9	0.4	79.5	
4833	RZM 3867m(Sp)aa x mm,O-T(C)	7113	28.02	12.71	149	2.4	0.0	77.9	
4834	RZM 3894m,aa x mm,O-T(C)	7018	27.28	12.90	142	2.8	0.0	77.5	
4893	RZM 3893	7016	27.78	12.65	151	2.8	2.0	76.5	
4859m	RZM 3859mmaa x A (C859)	6282	23.84	13.16	145	2.7	0.8	78.6	
4865m	RZM 3865mmaa x A	7469	27.82	13.48	153	2.9	0.0	77.1	
4865NB	NB 2865m(Sp)(%S) (A,aa)	5860	21.01	13.89	159	2.8	0.0	77.0	
4895	RZM 3280,...,3282 (A,aa)	6400	25.03	12.81	161	3.1	0.0	78.3	
Mean		6880.2	26.05	13.18	152.5	2.5	0.4	78.2	
LSD (.05)		915.7	3.06	0.68	15.8	0.6	1.7	2.2	
C.V. (%)		13.4	11.83	5.21	10.5	22.6	472.5	2.9	
F value		10.2**	9.23**	7.43**	1.3NS	5.6**	1.0NS	1.9*	

NOTES: See test 1695.

¹0790 = C790 and 0787 are self-fertile, monogerm, O-type, A:aa populations that are susceptible to rhizomania.
4894, 4859, 4865, & 4895 are S',mm,A:aa populations that segregate for R_z. 4831, 4832, 4833, 4834, & 4893 are S',mm,A:aa populations that segregate for R_z and were derived from composite crosses involving mm,O-T,CTR lines such as C562, C546, C718, C762-17, etc. 3911-4 = C911-4 = line from popn-911 that segregates for monogerm and is being used to establish new monogerm populations that have genetic variability for resistance to rhizomania, curly top, bolting, virus yellows, Erwinia, and powdery mildew. 5816 = version of C309 that segregates for genetic male sterility.

TEST 5695. RHIZOMANIA EVALUATION OF MONOGERM LINES SELECTED FOR GCA, SALINAS, CA., 1995

8 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 4, 1995
Harvested: October 16, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100' No.	Root Rot %	Powdery Mildew Score
		Sugar Lbs	Beets Tons				
F92-790-15H26	C309CMS x C790-15 (921191)	6871	24.60	14.00	170	0.4	1.8
4859- 2	Inc. 2859mA(Sp)-2 (A,aa)	6318	23.89	13.20	164	0.8	1.6
4864- 8	Inc. 0864- 8	7149	24.47	14.63	163	0.0	1.1
4864-14	Inc. 0864-14	7557	25.57	14.77	159	0.4	1.1
4864-34	Inc. 0864-34	6861	25.10	13.73	161	0.0	1.3
4865- 4	Inc. 2865mA(Sp)-4 (A,aa)	8020	27.67	14.49	178	0.0	1.5
4867- 1	Inc. 2867mA(Sp)-1 (A,aa)	6984	24.34	14.36	154	0.5	1.8
4891- 4	Inc. 2891mA(Sp)-4 (A,aa)	7050	24.58	14.35	174	0.0	1.5
Mean		7101.2	25.03	14.91	165.2	0.3	1.5
LSD (.05)		810.4	2.99	0.51	17.9	0.9	0.6
C.V. (%)		11.4	11.88	3.60	10.8	353.5	38.6
F value		3.2**	1.26NS	8.33**	1.7NS	0.9NS	1.7NS

NOTES: See tests 2195 and 5495. Test 5695 under moderate rhizomania. Except for C309CMS x C790-15, these are monogerm S₁ lines (seed from unbagged fertile plants in field, so there may be increases of mixed S₁ and/or HS sel.) selected from populations that segregate for R₂ and that are currently involved in experimental hybrids, O-type selection, and/or reselection for resistance to rhizomania (see tests 2195 & 5495).

TEST 2195. TESTCROSS HYBRID PERFORMANCE OF PROGENY SELECTIONS AND LINES, SALINAS, CA., 1995

24 entries x 8 replications, RCB (equalized)
1-row plots, 21 ft. long

Planted: April 14, 1995
Harvested: September 19-20, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100'	Powdery Mildew		RJAP %
		Sugar Lbs	Beets Tons			No.	%	
4454	Comm. check	10037	36.23	13.86	155		4.6	78.0
6770	High %S check	9621	31.69	15.21	149		5.2	80.1
4918H50	F92-790-15CMS x RZM 3918	10194	36.98	13.79	152		4.5	78.5
4918H59-1	2859mA(Sp)-1aa x RZM 3918	9483	33.63	14.11	149		5.3	78.9
4918H59-2	2859mA(Sp)-2aa x RZM 3918	9329	34.99	13.38	152		5.2	77.8
4918H59-8	2859mA(Sp)-8aa x RZM 3918	9768	34.34	14.21	149		5.0	78.1
4918H59-14	2859mA(Sp)-14aa x RZM 3918	8455	31.05	13.64	158		5.6	76.0
4918H59-21	2859mA(Sp)-21aa x RZM 3918	9572	33.46	14.31	153		5.2	78.9
4918H59-23	2859mA(Sp)-23aa x RZM 3918	8609	31.38	13.73	156		5.1	79.0
4918H65-21	2865Ma(Sp)-21aa x RZM 3918	8727	32.77	13.34	156		5.5	76.9
4918H67-1	2867mA(Sp)-1aa x RZM 3918	9354	34.12	13.73	152		4.7	78.2
4918H67-6	2867mA(Sp)-6aa x RZM 3918	9348	34.83	13.44	150		5.2	79.4
4918H91-10	2891mA(Sp)-10aa x RZM 3918	9731	35.42	13.75	152		5.0	78.8
4918H91-16	2891mA(Sp)-16aa x RZM 3918	9909	35.58	13.95	146		5.8	78.2
4918H91-20	2891mA(Sp)-20aa x RZM 3918	9671	35.58	13.61	152		5.2	77.9
4918H91-23	2891mA(Sp)-23aa x RZM 3918	9785	37.64	13.01	146		5.3	77.7
4918H91-42	2891mA(Sp)-42aa x RZM 3918	9764	36.29	13.49	149		5.4	77.5
4918H64-8	3864-8aa x RZM 3918	8957	31.87	14.04	155		5.9	79.0
4918H64-14	3864-14aa x RZM 3918	9416	34.83	13.54	161		5.2	77.4
4918H64-34	3864-34aa x RZM 3918	9972	36.94	13.49	148		5.0	77.1
4915H93	RZM 3890m,aa x RZM 3915	8966	33.58	13.36	148		5.1	77.4
4915H94	RZM 3894m,aa x RZM 3915	8761	33.26	13.19	156		5.4	76.7
3915H59	2859m(Sp)aa x 2915	8900	33.26	13.43	149		5.0	78.3
3915H67	2867m(Sp)aa x 2915	9029	35.04	12.90	155		5.2	77.4
Mean		9390.0	34.37	13.69	152.0		5.2	78.1
LSD (.05)		663.0	2.31	0.43	13.4		0.4	1.6
C.V. (%)		7.2	6.84	3.20	8.9		7.2	2.1
F value		4.2**	4.85**	9.63**	0.6NS		5.8**	2.5**

NOTES: See tests 5495 and 5695. Test 2195 without rhizomania. Based upon per se progeny tests in 1993, selected S₁ lines were top crossed and evaluated for hybrid performance. Top-cross tester ≈ C918. 2859 ≈ C859. 2891 ≈ C890.

TEST 5495. TESTCROSS HYBRID PERFORMANCE OF PROGENY SELECTIONS AND LINES, SALINAS, CA., 1995

24 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 4, 1995
Harvested: October 16, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100'	Root Rot %	Powdery Mildew Score
		Sugar Lbs	Beets Tons				
4581	2-16-94	8380	29.16	14.39	153	0.0	1.4
US H11	11-16-94	4286	18.54	11.54	174	0.0	2.8
4918H50	F92-790-15CMS x RZM 3918	8366	29.46	14.21	163	0.0	1.1
4918H59-1	2859mA(Sp) - 1aa x RZM 3918	9100	30.30	15.02	163	0.0	1.5
4918H59- 2	2859mA(Sp) - 2aa x RZM 3918	8205	28.89	14.23	157	0.0	1.9
4918H59- 8	2859mA(Sp) - 8aa x RZM 3918	8802	29.03	15.11	159	0.4	1.5
4918H59-14	2859mA(Sp) -14aa x RZM 3918	7904	27.73	14.25	159	0.4	2.3
4918H59-21	2859mA(Sp) -21aa x RZM 3918	7534	25.70	14.65	155	0.0	1.5
4918H59-23	2859mA(Sp) -23aa x RZM 3918	8447	28.67	14.73	158	0.0	1.3
4918H65-21	2865mA(Sp) -21aa x RZM 3918	7972	28.83	13.85	169	0.0	1.5
4918H67- 1	2867mA(Sp) - 1aa x RZM 3918	8740	29.72	14.71	159	0.0	1.4
4918H67- 6	2867mA(Sp) - 6aa x RZM 3918	8779	30.98	14.15	165	0.0	1.1
4918H91-10	2891mA(Sp) -10aa x RZM 3918	8570	28.93	14.81	164	0.0	1.6
4918H91-16	2891mA(Sp) -16aa x RZM 3918	8480	29.20	14.51	164	0.0	1.5
4918H91-20	2891mA(Sp) -20aa x RZM 3918	7601	26.83	14.11	169	0.0	1.6
4918H91-23	2891mA(Sp) -23aa x RZM 3918	8481	31.40	13.52	153	0.0	1.8
4918H91-42	2891mA(Sp) -42aa x RZM 3918	7892	29.46	13.39	161	0.0	1.5
4917H64- 8	3864- 8aa x RZM 3918	7822	27.04	14.48	166	0.0	1.6
4918H64-14	3864-14aa x RZM 3918	8421	29.23	14.43	153	0.5	1.8
4917H64-34	3864-34aa x RZM 3918	8741	30.40	14.36	168	0.0	1.3
4915H93	RZM 3890m,aa x RZM 3915	8521	30.77	13.86	161	0.0	1.1
4915H94	RZM 3894m,aa x RZM 3915	8680	30.67	14.15	166	0.0	1.6
3915H59	2859m(Sp)aa x 2915	8053	27.78	14.50	168	0.0	1.8
3915H67	2867m(Sp)aa x 2915	7907	27.83	14.19	163	0.0	1.5
Mean		8153.6	28.61	14.22	162.0	0.1	1.6
LSD (.05)		926.6	3.14	0.49	13.5	0.4	0.6
C.V. (%)		11.5	11.12	3.51	8.5	795.3	36.1
F value		7.7**	5.16**	16.02**	1.4NS	0.9NS	3.2**

NOTES: See tests 2195 and 5695. Test 5495 under moderate rhizomania.

TEST 1995. PERFORMANCE OF EXPERIMENTAL HYBRIDS, 1995

24 entries x 8 replications, RCB (equalized)
1-row plots, 21 ft. long

Planted: April 14, 1995
Harvested: September 20, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100'	Root Rot %	Powdery Mildew		RJAP %
		Sugar Lbs	Beets Tons						
KW6770	High %S check	9710	31.82	15.26	146	0.8	4.8		79.2
4454	Commercial check, Betaseed	10620	36.87	14.41	143	0.0	4.3		77.7
R484H50	F92-790-15CMS x RZM R384	9770	34.88	13.99	145	0.0	4.5		78.2
R476H50	F92-790-15CMS x RZM R376,Y	9576	36.60	13.07	148	0.0	4.3		78.3
R481-43H50	F92-790-15CMS x RZM R381-43	10004	35.96	13.91	156	0.0	4.4		78.6
R481-89H50	F92-790-15CMS x RZM R381-89	9835	36.78	13.38	140	0.0	4.2		78.2
R476-89-5H50	F92-790-15CMS x RZM R376-89-5	9734	34.45	14.14	152	0.0	4.7		79.1
R476-89-18H50	F92-790-15CMS x RZM R376-89-18	10270	37.64	13.66	146	0.4	4.6		77.6
R470H50	F92-790-15CMS x RZM R370	10411	37.64	13.82	151	0.4	4.1		78.4
R478H50	F92-790-15CMS x RZM R378,Y	10097	35.59	14.19	144	0.0	4.2		79.3
R479H50 (Iso)	F92-790-15CMS x RZM R379	9182	34.31	13.38	148	0.0	4.8		76.6
R480H50	F92-790-15CMS x RZM R380,Y	10045	35.28	14.21	140	0.4	4.6		79.5
R480-45H50	F92-790-15CMS x R280-45	10318	36.13	14.27	159	0.0	4.3		78.9
R483H50	F92-790-15CMS x RZM R383	10121	36.72	13.77	149	0.0	4.3		78.3
R422R4H50(Sp)	F92-790-15CMS x RZM R322R4,%	9459	34.99	13.49	155	0.0	5.0		77.1
R422Y3H50(Sp)	F92-790-15CMS x R322Y3, %	9698	33.53	14.48	148	0.4	4.5		79.1
R440H50	F92-790-15CMS x RZM R40(C)	9749	34.72	14.04	158	0.0	5.0		77.7
4915H50	F92-790-15CMS x RZM 3915	10638	38.08	13.98	151	0.0	4.2		78.2
4918H50	F92-790-15CMS x RZM 3918	10334	37.48	13.79	158	0.0	4.2		77.6
Z430H50	F92-790-15CMS x RZM Z330	10514	36.99	14.21	156	0.7	4.7		77.9
4918H52	F90-790-15H39 x RZM 3918	10039	38.18	13.15	154	0.0	4.0		77.1
4911H52	F90-790-15H39 x RZM 3911	10533	38.73	13.60	150	0.0	4.3		80.1
4916H52	F90-790-15H39 x RZM 3916	9707	37.32	12.98	150	0.0	4.3		79.2
4917H52	F90-790-15H39 x RZM 3917	9691	36.94	13.11	152	0.4	4.1		77.9
Mean		10002.2	36.15	13.85	149.9	0.1	4.4		78.3
LSD (.05)		693.5	2.11	0.53	12.1	0.6	0.4		2.2
C.V. (%)		7.0	5.94	3.89	8.2	441.0	8.7		2.9
F value		2.5**	4.74**	7.82**	1.6NS	1.2NS	4.3**		1.2NS

NOTES: See tests 1595 for performance under virus yellows and 4895 for performance under rhizomania and descriptions.

TEST 2095. PERFORMANCE OF HYBRIDS WITH LINES FROM POPULATIONS-913 & -915, SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 21 ft. long

Planted: April 14, 1995
Harvested: September 21, 1995

Variety ¹	Description ¹	Acre Yield		Sucrose %	Beets/ 100' No.	Powdery Mildew		RJAP %
		Sugar Lbs	Beets Tons			%	%	
4454	Commercial check, Betaseed							
KW6770	High %s check	10289	35.42	14.51	152	4.4		81.9
4918H50	F92-790-15CMS x RZM 3918(C918)	10388	32.78	15.86	144	5.3		82.2
4911-4H50	F92-790-15CMS x 3911-4(C911-4)	10076	36.13	13.96	151	4.1		79.1
		10296	35.80	14.36	152	4.3		80.2
4913-70H50	F92-790-15CMS x RZM 3913-70	10876	37.91	14.34	153	4.4		79.4
4913-71H50	F92-790-15CMS x RZM 3913-71	10540	38.40	13.73	152	4.3		79.8
4913-6H50	F92-790-15CMS x 3913-6	10110	35.33	14.31	165	4.7		79.5
4913-9H50	F92-790-15CMS x 3913-9	10098	37.53	13.44	151	4.2		77.2
4915-6H50	F92-790-15CMS x 3915-6	10433	36.78	14.19	156	4.4		79.7
4915-7H50	F92-790-15CMS x 3915-7	10606	36.29	14.60	163	4.4		79.8
4915-22H50	F92-790-15CMS x 3915-22	10334	35.68	14.49	149	4.5		80.5
4915-34H50	F92-790-15CMS x 3915-34	10035	35.42	14.19	146	4.3		79.8
Mean		10340.1	36.12	14.33	152.9	4.5		79.9
LSD (.05)		852.9	2.62	0.63	14.2	0.4		3.2
C.V.(%)		8.3	7.28	4.41	9.3	8.7		4.0
F value		0.7NS	2.52**	6.95**	1.5NS	5.1**		1.3NS

NOTES: Test 2095 under nondiseased conditions. See tests 4795 and 7295 for performance under rhizomania and 1595 for performance under virus yellows conditions.

¹F92-790-15CMS = C790-15CMS = C790-68CMS x C790-15. 3918 = C918 = MM,S^f,A:aa,Rz population. 3913-70 & -71 = S₁ lines from popn-913. 3913-6 & -9 = half-sib lines from popn-913. 3915-6,-7,-22, & -34 = half-sib lines from popn-915.

TEST 1595. VIRUS YELLOWS EVALUATION OF EXPERIMENTAL HYBRIDS, 1995

24 entries x 8 replications, RCB (equalized)
1-row plots, 21 ft. long

Planted: April 21, 1995
Harvested: September 27, 1995

Variety	Description	Acre Yield		Beets/ 100'	Sucrose %	Beets/ 100' No.	Virus Yellows Mean	Powdery		RJAP %
		Sugar Lbs	Beets Tons					Mildew %	%	
VVDH 6711 4454 KW6770 R476-89-18H50	VYR VDH hybrid (2-14-95)	5947	25.18	130	11.81	130	5.8	5.1	76.4	
	Comm check, Betaseed	6388	23.75	140	13.44	140	6.0	5.2	76.2	
	Susc., high %S check	4597	17.05	143	13.49	143	6.2	5.7	76.5	
	F92-790-15CMS x RZM R376-89-18	7165	27.19	149	13.18	149	5.7	4.5	76.9	
RR476-89-5H50 R481-43H50 R481-89H50 R484H50	F92-790-15CMS x RZM R376-89-5	7015	25.18	157	13.94	157	5.5	5.0	78.4	
	F92-790-15CMS x RZM R381-43	6921	25.97	153	13.31	153	5.6	4.4	76.5	
	F92-790-15CMS x RZM R381-89	7150	26.64	156	13.43	156	5.6	4.3	76.7	
	F92-790-15CMS x RZM R384	6946	26.13	158	13.30	158	5.7	4.4	78.5	
R480-45H50 R479H50 4915H50 4918H50	F92-790-15CMS x R280-45	6924	25.81	144	13.40	144	5.7	4.8	76.5	
	F92-790-15CMS x RZM R379	6295	24.70	158	12.75	158	5.7	5.0	76.7	
	F92-790-15CMS x RZM 3915	6776	26.17	157	12.96	157	5.6	4.6	76.3	
	F92-790-15CMS x RZM 3918	6794	26.00	157	13.05	157	5.6	4.8	77.2	
4911-4H50 4913-6H50 4913-9H50 4915-6H50	F92-790-15CMS x 3911-4m	6468	25.02	149	12.96	149	5.6	4.4	76.4	
	F92-790-15CMS x 3913-6	6351	24.39	157	13.01	157	5.6	4.6	75.6	
	F92-790-15CMS x 3913-9	6725	26.87	148	12.54	148	5.5	4.3	74.9	
	F92-790-15CMS x 3915-6	7189	27.13	158	13.25	158	5.7	4.5	76.6	
4915-7H50 4915-22H50 4915-34H50 R440H50	F92-790-15CMS x 3915-7	6990	25.65	152	13.63	152	5.6	4.7	77.3	
	F92-790-15CMS x 3915-22	6315	24.07	149	13.13	149	5.6	4.8	77.3	
	F92-790-15CMS x 3915-34	5885	23.00	139	12.76	139	5.7	4.4	75.4	
	F92-790-15CMS x RZM R40(C)	5982	22.65	158	13.20	158	5.7	5.0	76.1	
R422Y3H50 R422R4H50 R436R2H50 R470H50	F92-790-15CMS x R322Y3,%	6686	24.92	160	13.41	160	5.6	4.7	75.8	
	F92-790-15CMS x RZM R322R4,%	6163	24.60	162	12.51	162	5.7	5.3	75.0	
	F92-790-15CMS x RZM R336	5925	24.41	156	12.14	156	5.7	5.2	75.3	
	F92-790-15CMS x RZM R370	6522	24.65	155	13.25	155	5.7	4.7	76.7	
Mean		6504.9	24.88	151.9	13.08	151.9	5.7	4.8	76.5	
LSD (.05)		525.6	1.86	13.8	0.43	13.8	0.1	0.3	1.6	
C.V. (%)		8.2	7.59	9.2	3.36	9.2	1.9	7.2	2.1	
F value		9.5**	9.48**	2.6*	9.39**	2.6*	16.0**	8.4**	2.4*	

NOTES: See tests 1995 for nondiseased performance and 4895 for performance under rhizomania.

TEST 4795. HYBRID EVALUATION OF MULTIGERM LINES FROM S¹ RANDOM MATED POPULATIONS
UNDER RHIZOMANIA CONDITIONS, BLOCK 2-S, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: November 1, 1995

Variety ¹	Description ¹	Acre Yield		Beets/ 100'	Sucrose %	Powdery Mildew		Root Rot	RJAP %
		Sugar Lbs	Beets Tons			Mean	Mean		
US H11	11-16-94	5544	25.10	163	10.98	2.6		0.3	76.3
4581	2-16-94, Betaseed	9597	34.87	160	13.75	1.9		0.0	77.8
4918H50	F92-790-15CMS x RZM 3918, (C918)	9338	33.92	161	13.77	1.4		0.4	79.0
4911-4H50	F92-790-15CMS x 3911-4m, (C911-4)	9754	35.55	164	13.76	1.4		0.4	77.7
4913-70H50	F92-790-15CMS x RZM 3913-70	10102	35.66	163	14.20	1.4		0.0	78.8
4913-71H50	F92-790-15CMS x RZM 3913-71	10484	38.60	165	13.59	1.4		0.4	78.6
4913-6H50	F92-790-15CMS x 3913-6	8115	30.88	161	13.14	1.4		0.0	78.8
4913-9H50	F92-790-15CMS x 3913-9	8488	32.66	161	13.00	1.6		0.0	77.7
4915-6H50	F92-790-15CMS x 3915-6	9423	35.81	165	13.18	1.5		0.0	77.6
4915-7H50	F92-790-15CMS x 3915-7	9649	34.50	169	14.01	1.6		0.0	77.5
4915-22H50	F92-790-15CMS x 3915-22	9104	33.82	159	13.45	1.5		0.0	81.2
4915-34H50	F92-790-15CMS x 3915-34	9138	34.08	164	13.44	1.6		0.0	77.7
4918H52	F92-790-15H39 x RZM 3918, (C918)	8705	35.39	171	12.30	1.9		0.0	77.2
4911H52	F92-790-15H39 x RZM 3911	9269	35.66	164	12.98	1.6		0.4	78.7
4916H52	F92-790-15H39 x RZM 3916	8905	36.81	171	12.11	1.7		0.0	77.9
4917H52	F92-790-15H39 x RZM 3917	8022	33.55	160	11.94	1.7		0.9	78.3
Mean		8977.2	34.18	163.7	13.10	1.6		0.2	78.2
LSD (.05)		949.3	3.54	14.1	0.59	0.4		0.7	2.8
C.V. (%)		10.7	10.43	8.8	4.52	26.3		398.3	3.6
F value		11.2**	5.60**	0.5NS	17.29**	3.7**		1.1NS	1.2NS

NOTES: Test 4795 was grown under moderate rhizomania conditions. See tests 2095 for nondiseased performance, 1595 for performance under virus yellows, and 7295 for performance under severe rhizomania.

¹See test 2095 for descriptions. F92-790-15H39 = C762-17CMS x C790-15. 3918, 3911, 3916 = MM, S¹, A:aa, RZ populations. 3917 = MM, S¹, A:aa population similar to C39R (quantitative resistance to rhizomania).

TEST 4895. RHIZOMANIA EVALUATION OF HYBRIDS, BLOCK 2-S, SALINAS, CA., 1995

32 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 26, 1995

Variety ¹	Description ¹	Acre Yield		Beets/ 100'	Sucrose %	Powdery Mildew		Root Rot %	RJAP %
		Sugar Lbs	Beets Tons			Mean	Mean		
US H11	11-16-94	5530	23.11	162	12.02	1.1		0.0	81.3
Rizor	RZ3/1022 (1-21-93), SES	8848	29.06	156	15.23	2.1		0.0	78.4
Rival	4-12-95 (WS/HG test), Holly	9232	32.51	156	14.20	1.1		0.0	80.4
4581	2-16-94, Betaseed	8949	31.96	154	14.00	0.9		0.3	77.8
2J0179	9-9-94, Betaseed	8547	27.46	134	15.54	1.0		0.0	79.1
Rhizosen Plus	4-13-95 (WS/HG test), Holly	7896	27.78	158	14.21	0.9		0.0	79.8
H93433	4-18-95, Spreckels	8364	30.62	153	13.65	1.1		0.4	78.8
H944178	4-18-95, Spreckels	8630	32.68	164	13.20	0.6		0.4	80.3
R476H50	F92-790-15CMS x RZM R376,Y	8036	31.72	168	12.64	0.4		0.0	78.4
R484H50	" x RZM R384	8425	29.98	163	14.02	0.4		0.0	79.9
R470H50	" x RZM R370	8284	31.30	166	13.21	0.3		0.4	78.1
R478H50	" x RZM R378,Y	8930	32.35	170	13.80	0.4		0.0	79.3
R480H50	" x RZM R380,Y	9053	32.72	167	13.86	0.3		0.0	78.7
R480-45H50	" x R280-45	8992	32.24	161	13.95	0.5		0.0	79.3
R483H50	" x RZM R383	8556	31.82	163	13.45	0.3		0.0	80.0
R422R4H50 (Sp)	" x RZM R322R4,%	8716	32.30	164	13.54	0.5		0.4	78.8
R479H50 (Iso)	" x RZM R379	8508	31.77	168	13.39	0.5		0.0	79.1
R428R2H50	" x RZM R328	7203	27.25	159	13.23	0.5		0.0	79.2
R432R2H50	" x RZM R332	8663	34.76	171	12.50	0.4		0.7	77.4
R434R2H50	" x RZM R334	7676	27.20	169	14.11	0.9		0.0	80.3
R437R2H50	" x RZM R337	7796	29.35	162	13.27	0.5		0.4	77.9
4915H50	" x RZM 3915	7963	29.98	164	13.26	0.1		0.0	77.9
4918H50	" x RZM 3918	8255	30.04	164	13.71	0.3		0.0	81.0
Z430H50	" x RZM Z330	9154	32.98	166	13.89	0.6		0.0	79.1
R481-43H50	" x RZM R381-43	8526	31.77	163	13.41	0.1		0.0	78.6
R476-43-#H50	" x RZM R376-43-# (C)	8141	31.51	159	12.91	0.4		0.0	78.9
R476-43-14H50	" x RZM R376-43-14	8813	32.93	165	13.39	0.1		0.7	80.4
R476-43-15H50	" x RZM R376-43-15	8461	31.09	170	13.60	0.1		0.0	80.7

TEST 4895. RHIZOMANIA EVALUATION OF HYBRIDS, BLOCK 2-S, SALINAS, CA., 1995

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Sucrose %	Powdery Mildew		Root Rot %	RJAP %
		Sugar Lbs.	Beets Tons			Mean	Mean		
R481-89H50	F92-790-15CMS x RZM R381-89	8887	33.82	166	13.13	0.4	0.4	0.0	79.3
R476-89-#H50	" x RZM R376-89-#(C)	8393	31.61	164	13.27	0.4	0.4	0.4	78.6
R476-89-5H50	" x RZM R376-89-5	9407	32.09	161	14.65	0.6	0.6	0.0	79.3
R476-89-18H50	" x RZM R376-89-18	7328	27.49	159	13.32	0.3	0.3	0.0	80.4
Mean		8380.0	30.79	162.1	13.61	0.6	0.6	0.1	79.3
LSD (.05)		708.8	3.23	12.7	0.51	0.5	0.5	0.6	2.3
C.V. (%)		8.6	10.66	8.0	3.81	91.6	91.6	459.8	3.0
F value		8.4**	4.37**	2.3**	14.85**	5.3**	5.3**	1.1NS	1.4NS

NOTES: Test 4895 under moderate rhizomania. See tests 1995 for nondiseased performance and 1595 for performance under virus yellows. The relative performance of the H50 hybrids appears primarily to be due to the gene frequency for resistance to rhizomania in the pollinator. For example, R376-89-5 has a high frequency of plants resistant to rhizomania; R376-89-18 appears to have a low frequency or devoid of plants resistant to rhizomania.

F92-790-15CMS = C790-15CMS = C790-68CMS x C790-15. R378,Y ≈ C78. R380,Y ≈ C80. R280-45 = C80-45. R379 = C79-1. R328 ≈ C79-4. R332 ≈ C79-5. R334 ≈ C79-6. R337 ≈ C79-9. R318 = C918. R376-43-# ≈ C76-43. R376-43-14 = C76-43-14. R376-43-15 = C76-43-15. R376-89-# ≈ C76-89. R376-89-5 = C76-89-5. R376-89-18 = C76-89-18.

TEST 7295. PERFORMANCE OF EXPERIMENTAL HYBRIDS, FIELD C, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 31, 1995
Harvested: November 15, 1995

Variety ¹	Description ¹	Acre Yield		Beets/ 100'	Sucrose %	CLS		RJAP %
		Sugar Lbs	Beets Tons			No.	Score ²	
4581	3072 (2-16-94), Betaseed	5804	20.16	180	14.44		3.1	77.1
US H11	11-16-94	2537	11.38	196	11.07		3.5	75.4
R378H52	F92-790-15H39 x R278,Y	5238	19.78	187	13.25		3.4	78.9
R380H52	F92-790-15H39 x R280,Y	5184	19.44	174	13.31		3.0	77.8
R479H52	F92-790-15H39 x R379	4851	18.99	193	12.81		2.6	77.2
R422R4H52	F92-790-15H39 x RZM R322R4, %	7242	29.18	183	12.46		2.6	77.6
4918H52	F92-790-15H39 x RZM 3918(C918)	4232	17.30	184	12.25		3.9	75.5
4911-4H52	F92-790-15H39 x 3911-4m(C911-4)	5609	21.53	182	13.06		2.3	76.3
4913-6H52	F92-790-15H39 x 3913-6	3563	15.26	184	11.66		3.8	73.9
4913-9H52	F92-790-15H39 x 3913-9	4190	16.96	190	12.34		3.5	77.6
4915-6H52	F92-790-15H39 x 3915-6	4959	19.72	177	12.61		2.9	77.7
4915-7H52	F92-790-15H39 x 3915-7	4426	16.72	181	13.23		3.4	76.5
4915-22H52	F92-790-15H39 x 3915-22	5022	19.45	165	12.93		3.1	78.4
4915-34H52	F92-790-15H39 x 3915-34	4793	18.89	164	12.71		3.4	77.0
4911H52	F92-790-15H39 x RZM 3911	4812	19.02	170	12.68		3.6	77.0
4917H52	F92-790-15H39 x RZM 3917	4310	18.58	179	11.70		2.5	77.2
Mean		4798.3	18.90	180.5	12.66		3.2	77.0
LSD (.05)		550.4	2.10	15.9	0.65		0.8	3.3
C.V. (%)		11.6	11.23	8.9	5.18		24.6	4.3
F value		27.2**	23.33**	2.5**	11.50**		3.0**	1.1NS

NOTES: Test 7295 under severe rhizomania conditions. See tests 2095 for nondiseased performance, 1595 for performance under virus yellows, and 4795 for moderate rhizomania.

¹See test 2095 for descriptions. F92-790-15H39 = C762-17CMS x C790-15. R278 ≈ C78. R280 ≈ C80. R379 = C79-1 = C37Rz. R322R4,% = cycle 5 selection from R22(C50) for resistance to rhizomania. R22 = Y54 x B.maritima.

²Cercospora leaf spot scored on a scale of 0 to 9 where 9 = complete defoliation.

TEST 1895. IIRB YIELD TEST WITHOUT RHIZOMANIA, SALINAS, CA., 1995

12 entries x 8 replications, RCB
1-row plots, 21 ft. long

Planted: April 14, 1995
Harvested: September 21, 1995

Variety	Description ¹	Acre Yield		Sucrose %	Beets/ 100'	Root Rot ² %	Powdery Mildew ³ %		RJAP ⁴ %
		Sugar Lbs	Beets Tons						
US H11	113401 (11-16-94)	8879	32.71	13.58	156	0.0	5.8		80.2
R378H52	F92-790-15H39 x R278	10733	40.30	13.31	156	0.0	4.4		80.6
Accord	IIRB, 1995	10078	36.49	13.85	124	0.5	4.7		80.0
Monodoro	IIRB, 1995	9227	32.83	14.03	127	0.0	4.6		81.5
Rizor	IIRB, 1995	9879	31.90	15.51	121	0.0	5.7		82.2
Stratos	IIRB, 1995	9655	33.84	14.23	127	0.4	4.8		79.4
Roxane	IIRB, 1995	9436	34.05	13.88	114	1.0	5.0		80.1
Patricia	IIRB, 1995	11404	38.98	14.63	151	0.4	4.8		82.8
4918H52	F92-790-15H39 x RZM 3918	10588	40.46	13.06	148	0.0	4.3		79.9
R422R4H52	F92-790-15H39 x RZM R322R4, %	9660	37.10	12.98	154	0.0	4.9		80.5
R422Y3H52	F92-790-15H39 x R322Y3, %	10570	38.04	13.89	146	0.4	4.3		80.9
R440H52	F92-790-15H39 x RZM R40(C)	9311	35.80	12.99	142	0.4	4.8		80.5
Mean		9951.6	36.04	13.83	138.7	0.3	4.9		80.7
LSD (.05)		1061.2	3.26	0.62	12.3	1.1	0.3		2.3
C.V. (%)		10.7	9.09	4.53	8.9	401.1	6.4		2.9
F value		3.9**	6.70**	11.15**	12.2**	0.8NS	18.3**		1.5NS

NOTES: For results under rhizomania, see tests 3495, 4495, and 7195. These tests are part of an international study sponsored by IIRB to determine if there are variety x location interactions with regard to performance under rhizomania conditions. In addition to the standard set of 6 entries from IIRB, I included additional susceptible and resistant entries. Always included were US H11, highly rhizomania susceptible hybrid, and R378H52, a USDA experimental hybrid with the R₂ factor.

¹F92-790-15H39 = C762-17CMS x C790-15. 3918 ≈ C918 ≈ S¹A:aa,Rz popn. R322R4 ≈ cycle 5 selection from C50 (R22) for resistance to rhizomania. R322Y3 ≈ cycle 3 selection from C50 (R22 = Y54 x B.m.) for virus yellows (BYV/BWYV) resistance. R40(C) ≈ composite in C37 background with combined sources of resistance to rhizomania.

²Root rot was primarily caused by Erwinia.

³Powdery mildew scored on a scale of 0 to 9 where 9 = highly infected. PM during most of season controlled by Bayleton.

⁴RJAP = raw juice apparent purity = % sucrose(pol)/total soluble solids.

TEST 1895. IIRB YIELD TEST WITHOUT RHIZOMANIA, SALINAS, CA., 1995

(cont.)

Variety	Recover. Sugar's lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known Sugar/Loss lbs/a	Sodium ppm	Potassium ppm	NH ₂ -N ppm	Impur. Value
US H11	7860	240	88.5	1019	694	1646	406	10400
R378H52	9443	234	87.9	1290	745	1771	382	10667
Accord	8939	246	88.7	1139	919	1584	331	10324
Monodoro	8200	249	88.9	1027	723	1652	395	10406
Rizor	8858	278	89.7	1021	585	1793	434	10655
Stratos	8452	249	87.4	1203	972	1623	467	11891
Roxane	8161	240	86.4	1275	940	1843	479	12448
Patricia	10262	263	90.0	1142	824	1542	316	9736
4918H52	9148	226	86.3	1440	862	1841	446	11859
R422R4H52	8464	227	87.5	1196	769	1730	396	10778
R422Y3H52	9352	246	88.5	1217	663	1842	395	10674
R440H52	8071	225	86.6	1240	754	1937	428	11547
Mean	8767.5	243.7	88.0	1184.2	787.4	1733.5	406.2	10948.8
LSD (.05)	981.1	13.6	1.3	147.1	109.1	126.5	47.0	827.5
C.V. (%)	11.2	5.6	1.5	12.5	13.9	7.3	11.6	7.6
F value	4.1**	10.5**	7.4**	5.7**	9.3**	7.5**	8.7**	7.4**

'Recoverable sugar calculated from impurity value, where Impurity Value = (3.5 x ppm Na) + (2.5 x ppm K) + (9.5 x ppm NH₂-N).

TEST 3495. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, BLOCK 2-N, SALINAS, CA., 1995

16 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: March 29, 1995
Harvested: October 4, 1995

Variety	Description	Acre Yield		Beets/ 100'	Sucrose %	Beets/ 100'	Root Rot	Bolting %	RJAP %
		Sugar Lbs	Beets Tons						
3495-1 IIRB entries									
US H11	113401 (11-16-94)	3958	18.04		10.93	128	0.0	0.0	75.6
R378H52	F92-790-15H39 x R278	7331	26.68		13.70	136	0.4	0.0	78.2
Accord	IIRB, 1995	3101	13.69		11.46	106	0.0	0.0	74.7
Monodoro	IIRB, 1995	5850	22.07		13.30	111	0.5	0.0	76.9
Rizor	IIRB, 1995	7390	24.23		15.27	112	0.0	0.0	77.2
Stratos	IIRB, 1995	5660	19.49		14.58	103	1.2	0.0	76.3
Roxane	IIRB, 1995	4257	17.66		12.06	97	1.6	0.0	76.6
Patricia	IIRB, 1995	7288	24.94		14.61	133	0.0	0.0	78.0
Mean		5604.1	20.85		13.24	115.8	0.5	0.0	76.7
LSD (.05)		1272.8	4.69		0.54	20.0	1.9		2.6
C.V. (%)		22.6	22.38		4.08	17.2	392.8		3.3
F value		14.2**	7.07**		70.38**	4.3**	0.9NS		1.7NS
3495-2 USDA entries									
6770	KWS %S check	4946	18.18		13.53	125	0.8	0.0	77.9
4581	3072 (2/16/94)	6979	24.75		14.14	132	0.0	0.0	78.7
4918H52	F92-790-15H39 x RZM 3918	5215	20.66		12.63	117	0.6	0.0	76.9
R440H18	3918aa x RZM R40(C)	5684	21.31		13.32	128	0.6	0.0	78.6
R422R4H52	F92-790-15H39 x R322R4, %	7469	29.36		12.69	123	8.4	0.4	76.4
R422R4 (Sp)	RZM R322R4, %	7395	28.18		13.14	122	1.8	4.5	74.5
R443	RZM 3284,5 [R81-89 x (C37 x R22)]	6367	23.70		13.45	133	0.4	0.0	76.8
R422Y3H15	3915aa x R322Y3, %	6646	23.88		13.96	130	0.0	0.0	76.9
Mean		6337.7	23.75		13.36	126.1	1.6	0.6	77.1
LSD (.05)		966.9	3.29		0.51	23.6	2.4	1.8	2.3
C.V. (%)		15.2	13.79		3.79	18.6	153.0	291.9	3.0
F value		8.1**	10.51**		9.13**	0.4NS	10.8**	6.1**	2.7*

TEST 3495. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, BLOCK 2-N, SALINAS, CA., 1995

16 entries x 8 replications, RCB. ANOVA to compare means across sets of entries.							
Mean		5970.9	22.30	13.30	120.9	1.0	76.9
LSD (.05)		1112.6	3.94	0.62	22.0	2.1	2.5
C.V. (%)		18.8	17.81	4.69	18.4	205.7	3.3
F value		12.1**	9.04**	27.45**	2.3**	7.5**	1.9*

TEST 3495. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, BLOCK 2-N, SALINAS, CA., 1995
(cont.)

Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known Sugar/Loss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
3495-1 IIRB entries								
US H11	3497	193	88.0	461	1160	1312	131	8580
R378H52	6727	251	91.6	604	640	1244	242	7649
Accord	2710	201	87.6	391	1251	1457	145	9402
Monodoro	5349	244	91.5	501	840	1073	192	7448
Rizor	6762	280	91.6	628	486	1321	366	8477
Stratos	5163	266	91.1	496	730	1057	356	8575
Roxane	3731	211	87.5	525	1193	1432	227	9916
Patricia	6739	270	92.3	549	802	1048	206	7379
Mean	5084.7	239.5	90.2	519.4	887.7	1243.0	233.0	8428.0
LSD (.05)	1173.2	13.0	1.8	142.9	172.9	140.9	104.4	1262.8
C.V. (%)	23.0	5.4	1.9	27.4	19.4	11.3	44.6	14.9
F value	15.4**	54.1**	11.3**	2.3*	21.5**	11.3**	5.7**	4.3**
3495-2 USDA entries								
6770	4589	251	92.7	357	763	987	146	6530
4581	6429	261	92.1	550	666	1046	256	7375
4918H52	4719	229	90.4	497	783	1219	236	8032
R440H18	5179	243	91.1	505	651	1341	234	7854
R422R4H52	6665	226	89.0	804	730	1355	346	9226
R422R4	6568	233	88.8	827	535	1439	452	9757
R443	5767	244	90.6	600	545	1246	360	8444
R422Y3H15	6099	257	91.9	547	563	1330	237	7547
Mean	5751.9	242.9	90.8	585.8	654.4	1245.3	283.4	8095.5
LSD (.05)	934.1	11.7	1.6	99.9	104.5	148.8	105.6	1265.7
C.V. (%)	16.2	4.8	1.7	17.0	15.9	11.9	37.1	15.6
F value	6.4**	9.7**	6.4**	20.3**	7.3**	9.0**	6.7**	5.4**
TEST 3495. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, BLOCK 2-N, SALINAS, CA., 1995								
16 entries x 8 replications, RCB. ANOVA to compare means across sets of entries.								
Mean	5418.3	241.2	90.5	552.6	771.0	1244.1	258.2	8261.8
LSD (.05)	1054.4	15.1	1.9	129.8	158.3	152.2	110.5	1421.6
C.V. (%)	19.6	6.3	2.2	23.7	20.7	12.3	43.2	17.4
F value	11.8**	20.9**	6.4**	7.3**	17.6**	8.3**	5.5**	3.6**

NOTES: See tests 1895, 4495, and 7195.

TEST 4495. IIRB YIELD TEST UNDER MODERATE RHIZOMANIA CONDITIONS, BLOCK 2-S, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: November 3, 1995

Variety	Description	Acre Yield		Beets/ 100'	Sucrose %	Powdery Mildew		Root Rot %	RJAP %
		Sugar	Beets			Mean			
		Lbs	Tons						
IIRB entries 4495-1. 8 x 8 Ls									
US H11	113401 (11-16-94)	5805	25.41	154	11.36	2.9	0.0	80.2	
R378H52	F92-790-15H39 x R278	9775	38.64	153	12.66	2.2	0.4	81.2	
Accord	IIRB, 1995	5692	24.67	133	11.49	2.1	0.0	79.9	
Monodoro	IIRB, 1995	9088	35.19	138	12.90	2.0	1.4	79.8	
Rizor	IIRB, 1995	9716	32.44	144	14.96	2.6	0.0	79.4	
Stratos	IIRB, 1995	10215	37.47	148	13.63	2.4	0.9	78.6	
Roxane	IIRB, 1995	7606	31.44	136	12.09	2.6	0.4	80.4	
Patricia	IIRB, 1995	10545	37.59	150	14.01	1.8	0.4	80.8	
Mean		8555.3	32.86	144.4	12.89	2.3	0.4	80.0	
LSD (.05)		795.4	2.95	11.9	0.53	0.5	1.1	2.0	
C.V. (%)		9.3	8.90	97.6	4.07	22.4	251.2	2.5	
F value		48.3**	27.40**	3.8*	46.14**	4.2**	1.6NS	1.3NS	

USDA entries 4495-2. 8 x 8 LS

6770	KWS % check	7346	26.36	151	13.99	2.4	0.0	0.0	82.3
4581	3072 (2-16-94) Betaseed	9261	32.34	139	14.31	2.2	1.4	1.4	82.2
4918H52	F92-790-15H39 x RZM 3918	8573	34.34	143	12.51	1.8	0.0	0.0	79.5
R440H18	3818aa x RZM R40(C)	8203	31.08	153	13.18	2.3	0.0	0.0	80.6
R422R4H52	F92-790-15H39 x R322R4, %	9611	39.01	145	12.32	2.6	2.5	2.5	79.5
R422R4 (Sp)	RZM R322R4, %	8655	34.48	144	12.54	2.6	2.7	2.7	76.9
R443	RZM 3284,5,(R81-89 x (C37 x R22))	9183	34.39	144	13.36	2.4	1.0	1.0	79.6
R422Y3H15	3915aa x R322Y3, %	9214	33.76	151	13.64	1.9	0.8	0.8	79.3
Mean		8755.8	33.22	146.2	13.23	2.3	1.1	1.1	80.0
LSD (.05)		826.1	3.11	12.6	0.39	0.5	2.1	2.1	
C.V. (%)		9.4	9.32	8.6	2.94	20.0	198.1	2.6	
F value		6.3**	10.78**	1.2NS	28.3**	4.1**	2.2NS	5.9**	

TEST 4495. IIRB YIELD TEST UNDER MODERATE RHIZOMANIA CONDITIONS, BLOCK 2-S, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized). 2 subtests, 8 x 8, RCB (equalized).
1-row plots, 20 ft. long. ANOVA to compare means across sets.

Mean		8655.5	33.04	145.3	13.06	2.3	0.8	0.8	80.0
LSD (.05)		839.1	3.00	13.3	0.55	0.5	1.7	1.7	2.2
C.V. (%)		9.8	9.16	9.2	4.23	22.4	234.6	2.8	
F value		22.5**	17.36**	1.9NS	26.80**	3.5**	2.0*	2.7**	

TEST 4495. IIRB YIELD TEST UNDER MODERATE RHIZOMANIA CONDITIONS, BLOCK 2-S, SALINAS, CA., 1995
(cont.)

Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known Sugar/Loss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
<u>IIRB entries 4495-1. 8 x 8 LS</u>								
US H11	5028	196	86.2	777	1276	1376	249	10272
R378H52	8445	219	86.4	1330	1060	1583	401	11476
Accord	4844	195	84.5	848	1588	1495	238	11555
Monodoro	7897	224	86.9	1191	1189	1423	371	11245
Rizor	8511	262	87.5	1205	678	1606	635	12417
Stratos	8855	236	86.6	1360	1227	1302	481	12113
Roxane	6431	204	84.3	1175	1588	1530	328	12497
Patricia	9306	247	88.1	1239	1174	1304	387	11046
Mean	7414.5	223.0	86.3	1140.8	1222.3	1452.2	386.2	11577.6
LSD (.05)	708.5	11.2	1.3	114.1	129.8	113.5	46.2	679.3
C.V. (%)	9.5	5.0	1.5	10.0	10.6	7.8	11.9	5.8
F value	49.3**	38.4**	8.1*	28.3**	40.9**	9.0**	62.4**	9.9*
<u>USDA entries 4495-2. 8 x 8 LS</u>								
6770	6632	253	90.4	715	1033	1254	226	8899
4581	8196	253	88.4	1065	913	1456	438	10995
4918H52	7412	216	86.5	1162	1058	1508	398	11249
R440H18	7158	230	87.1	1046	846	1750	414	11273
R422R4H52	8051	206	83.7	1560	1032	1821	544	13335
R422R4 (Sp)	7168	207	82.6	1487	926	1923	678	14486
R443	7849	228	85.4	1334	758	1598	664	12956
R422Y3H15	8014	237	87.0	1199	856	1670	493	11848
Mean	7559.9	229.0	86.4	1195.8	927.6	1622.3	481.8	11880.0
LSD (.05)	721.2	1.1	1.1	149.4	117.7	115.4	65.3	867.7
C.V. (%)	9.5	0.5	1.3	12.4	12.6	7.1	13.5	7.3
F value	4.7&&	75.0**	39.7**	26.3**	6.7**	28.2**	41.9**	31.4**

TEST 4495. IIRB YIELD TEST UNDER MODERATE RHIZOMANIA CONDITIONS, BLOCK 2-S, SALINAS, CA., 1995
16 entries x 8 reps., RCB (equalized). 2 subtests, 8 x 8, RCB (equalized). ANOVA to compare means across sets.

Mean	7487.2	226.0	86.3	1168.3	1075.0	1537.3	434.0	11728.8
LSD (.05)	756.7	11.9	1.4	134.3	141.6	122.7	61.3	866.3
C.V. (%)	10.2	5.3	1.7	11.6	13.3	8.1	14.3	7.5
F value	21.6**	24.4**	14.5**	24.3**	26.7**	18.8**	42.6**	17.3*

TEST 7195. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, FIELD C, SALINAS, CA., 1995

16 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 31, 1995
Harvested: November 16, 1995

Variety	Description	Acre Yield		Sugar Lbs	Beets Tons	Sucrose %	Beets/ 100'	CLS Score	RJAP %
		Sugar Lbs	Beets Tons						
7195-1. IIRB entries									
US H11	113401 (11-16-94)	2743	12.98			10.55	168	2.9	74.6
R378H52	F92-790-15H39 x R278	5785	22.43			12.96	169	3.0	76.7
Accord	IIRB, 1995	3525	15.25			11.63	149	3.8	75.9
Monodoro	IIRB, 1995	5011	18.64			13.44	156	1.6	77.1
Rizor	IIRB, 1995	6481	21.00			15.45	166	4.9	76.9
Stratos	IIRB, 1995	4516	17.69			12.70	154	6.4	75.7
Roxane	IIRB, 1995	3933	16.52			11.88	151	3.8	76.6
Patricia	IIRB, 1995	6392	23.04			13.88	166	4.4	78.3
Mean		4798.4	18.44			12.81	159.9	3.8	76.5
LSD (.05)		668.6	2.39			0.69	13.6	0.9	2.4
C.V. (%)		13.9	12.90			5.39	8.5	23.6	3.1
F value		33.7**	17.75**			38.20**	2.8*	20.0**	1.6NS
7195-2. USDA entries									
6770	KWS %S check	3918	14.75			13.45	172	3.9	78.5
4581	3072 (2-16-94) Betaseed	5978	21.15			14.18	176	2.9	76.9
R422R4H52	F92-790-15H39 x R322R4, %	6372	26.27			12.16	174	2.6	76.1
R422R4 (Sp)	RZM R322R4, %	6152	24.24			12.73	174	2.9	74.2
Rival	4-12-95 (WS/HG test)	6351	21.49			14.76	158	2.0	77.6
HM 1815	3-28-95 (WS/HG test)	5490	19.19			14.27	172	4.4	78.5
SS-781R	4-18-95, Spreckels	5472	20.16			13.61	166	2.5	78.6
Kojak	Seedex (WS/HG test)	5312	19.43			13.63	175	2.8	78.3
Mean		5630.6	20.83			13.60	170.8	3.0	77.4
LSD (.05)		732.9	2.61			0.74	11.4	1.1	2.2
C.V. (%)		13.0	12.47			5.44	6.6	35.9	2.8
F value		9.8**	14.21**			10.44**	2.3NS	4.1**	4.1**

TEST 7195. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, FIELD C, SALINAS, CA., 1995
16 entries x 8 replications, RCB (equalized). 2 subtests, 8 x 8, RCB (equalized).
1-row plots, 20 ft. long. ANOVA to compare means across sets.

Mean	5214.5	19.64	13.20	165.4	3.4	76.9
LSD (.05)	747.7	2.65	0.74	12.6	1.0	2.3
C.V. (%)	14.5	13.63	5.68	7.7	29.7	3.0
F value	19.1**	14.47**	22.16**	3.9**	11.2**	2.8**

TEST 7195. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, FIELD C, SALINAS, CA., 1995
(cont.)

Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known Sugar/Loss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
<u>7195-1. IIRB entries</u>								
US H11	2275	175	82.5	469	1828	1785	122	12018
R378H52	5027	226	86.9	758	1275	1799	234	11184
Accord	2940	194	83.4	585	1965	1795	150	12789
Monodoro	4426	238	88.3	586	1376	1650	155	10412
Rizor	5824	278	89.9	656	873	1783	306	10418
Stratos	3876	218	85.7	641	1687	1526	238	11976
Roxane	3325	201	84.1	609	1974	1635	140	12327
Patricia	5631	245	88.1	762	1617	1416	187	10973
Mean	4165.3	221.7	86.1	633.1	1574.3	1673.5	191.4	11512.0
LSD (.05)	602.4	16.2	2.0	1.4	201.9	257.8	27.2	1003.5
C.V. (%)	14.4	7.3	2.4	15.3	12.8	15.3	14.1	8.7
F value	36.8**	32.3**	13.5**	7.9**	28.7**	2.5*	43.1**	6.4**
<u>7195-2. USDA entries</u>								
6770	3464	240	88.9	453	1168	1702	157	9830
4581	5341	253	89.2	637	1054	1592	249	10035
R422R4H52	5374	205	84.4	998	1319	1938	329	12588
R422R4 (Sp)	5196	215	84.5	956	1108	2017	445	13146
Rival	5759	268	90.7	592	934	1525	210	9075
HM 1815	4940	257	89.8	550	1027	1559	223	9608
SS-781R	4830	241	88.3	642	1173	1804	202	10533
Kojak	4780	245	90.0	532	1193	1451	137	9099
Mean	4960.5	240.5	88.2	670.1	1122.0	1698.4	243.8	10489.3
LSD (.05)	665.4	16.7	1.7	124.8	160.3	264.0	43.7	1076.9
C.V. (%)	13.4	6.9	1.9	18.5	14.2	15.5	17.8	10.2
F value	8.6**	12.7**	17.3**	20.6**	4.4**	4.8**	42.5**	16.7**

TEST 7195. IIRB YIELD TEST UNDER SEVERE RHIZOMANIA, FIELD C, SALINAS, CA., 1995

16 entries x 8 reps., RCB (equalized). 2 subtests, 8 x 8, RCB (equalized). ANOVA to compare means across sets.

Mean	4562.9	231.1	87.2	651.6	1348.2	1685.9	217.6	11000.7
LSD (.05)	673.6	16.9	1.9	117.5	194.0	270.7	37.8	1036.5
C.V. (%)	14.9	7.4	2.2	18.2	14.5	16.2	17.6	9.5
F value	20.1**	21.6**	16.0**	13.2**	26.8**	3.1**	39.7**	12.9**

TEST 4595. WS/HG RHIZOMANIA TESTS, SALINAS, CA., 1995

32 entries x 8 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 23 & 30, 1995

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
		Sugar Lbs	Beets Tons				DI	%R
Beta 4006	(Beta 2J0179)	6934	24.68	123	0.5	77.2	3.8	54.8
Beta 4J0197	Betaseed	8688	29.55	160	0.0	78.1	3.7	59.8
HM 1632	Hilleshog-MH	7635	29.15	159	0.0	77.5	3.9	53.7
HM 1633	Hilleshog-MH	7159	28.05	166	0.0	77.6	3.8	57.8
Rhizosen	Holly	5747	21.90	167	0.0	80.4	4.3	43.5
95 HX326	Holly	6905	25.48	160	0.0	78.6	3.7	63.2
Kojak	Seedex	7824	29.04	162	0.0	78.7	3.8	59.6
SX 0216	Seedex	6067	24.31	158	0.0	77.8	3.9	54.3
H92505	Spreckels	7261	26.96	147	0.0	79.0	4.3	43.8
H93861	Spreckels	6688	24.94	168	0.0	77.5	4.0	52.3
H93694	Spreckels	7978	31.76	168	0.0	78.1	3.7	62.9
HH50	Holly	5460	22.45	173	0.0	78.1	4.3	39.3
ACH 203	Amer. Crystal	5858	23.85	176	0.0	77.9	4.1	46.3
Monohikari	Seedex check	5530	20.52	173	0.0	79.9	4.4	37.4
Maribo 9372	Maribo	7192	25.73	168	0.0	77.1	3.7	61.9
Beta 2J0152	Betaseed	9217	33.08	161	0.0	76.9	3.5	70.1
95HX326	Holly	6399	22.92	157	0.0	77.8	3.8	62.4
Beta 3BG6328	Betaseed	7839	26.37	100	2.1	78.9	3.7	65.1
Rhizosen CT	Holly	6833	27.47	163	0.0	77.2	4.3	42.1
95 HX329	Holly	6629	26.54	156	0.0	78.0	3.7	63.2
H93478	Spreckels	5832	22.83	158	0.0	78.1	4.6	34.6
HM 1815	Hilleshog-MH	6982	27.71	172	0.0	77.1	3.3	72.4
Rhizosen Plus	Holly	7732	28.39	153	0.0	78.1	3.9	56.8
Rival	Holly	8067	29.07	159	0.0	76.4	3.6	64.2
93HX120	Holly	5680	23.18	162	0.0	80.1	4.0	52.1
95HX310	Holly	7044	28.44	159	0.4	76.5	3.4	75.6
95HX317	Holly	6967	25.56	164	0.8	77.7	3.7	67.0
FD 9516	Desprez(F-M), 2-21-95	7683	31.44	163	0.0	74.9	3.6	69.0

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
		Sugar Lbs	Beets Tons				DI	%R
US H11 Rizor R422R4H52	11-16-94	4220	18.80	11.01	0.0	78.1	4.4	36.7
	RZ3/1022 (1-21-93)	8107	27.25	14.84	0.0	75.2	3.7	61.9
	F92-790-15H52 x RZM R422R4, %	8056	34.46	11.62	0.0	74.9	3.7	62.4
4918H52	F92-790-15H52 x RZM 3918	7255	30.04	12.06	0.0	77.6	3.8	62.3
Mean		6983.4	26.62	13.06	0.1	77.7	3.9	56.5
LSD (.05)		748.2	2.80	0.53	0.9	1.8	0.4	12.1
C.V. (%)		10.9	10.65	4.15	796.6	2.4	8.9	21.5
F value		15.6**	12.93**	23.90**	21.3**	3.8**	3.3**	3.3**

Notes: Entries 1 through 27 were submitted by Western Sugar and Holly Growers Seed Evaluation Committees. FD 9516 was submitted by Ferry-Morse Seed Company for Desprez. US H11, Rizor, R422R4H52, and 4918H52 were USDA entries. US H11 is a highly susceptible check. Rizor is a moderately resistant check. R422R4H52 is an experimental hybrid with resistance to rhizomania from C50 (*Beta maritima*). 4918H52 segregates for resistance from RZ (Holly source).

Root rot appeared to be caused by Erwinia.

RJAP = raw juice apparent purity.

Test area was under high nitrogen status and was watered twice per week. Despite rhizomania and cyst nematode, top growth was very good and a differential green vs yellowing due to rhizomania did not occur. Stands were good and except for two entries (numbers 1 and 18), adjustments for gaps were unnecessary.

Replications 1-4 were grown under moderately severe rhizomania conditions. These 4 replications were harvested manually and scored by individual roots for reaction to rhizomania. For 4595-1, the tops were flailed and roots lifted, scored, topped, washed, weighed, and run through the sugar laboratory. For most plots, there were two sugar samples. The individual roots were scored on a scale of 0-9, where 0 = no disease and 9 = dead. Mostly in this test, ratings of 1,3,5, and 7 were used. Ratings of 0-4 were considered resistant and 5-9 susceptible. Based upon US H11, approximately 36% of the roots were escapes or partially escapes. Conversely, because of high cyst nematode infestation, some rhizomania resistant roots were probably scored as susceptible. Thus the rhizomania ratings of DI (disease index) and %R (% resistant) are biased in both directions (by escapes and nematodes). These varietal ratings should not be viewed as precise measurements for frequency of resistant individuals, but as an index of relative reaction to rhizomania. As a comparative relative value, they appear

TEST 4595. WS/HG RHIZOMANIA TESTS, SALINAS, CA., 1995

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
		Sugar Lbs.	Beets Tons				DI	%R
				Sucrose %				

to be good estimates and to fit expectations for known entries. It is still the judgement of the tester (RTL, USDA) that gross sugar yield is the best relative measure of disease reaction when the relative yield of the entries under nonrhizomania conditions also is known in the area of their adaptation. That the overall effects of rhizomania are so important, that within a set of entries of similar performance capacities, that ranking will reflect relative reaction to rhizomania. Even for roots that scored resistant but are actually susceptible, e.g., those of US H11, the tap root may have initially escaped infection and thus severe bearding, but many of the lateral and feeder root (not accounted for when scored) would be infected and fully involved with the disease and thus cause a reduction in sugar yield. The relationship between sugar yield vs DI and sugar yield vs %R was not as high as in the 1994 tests. For Test 4595-1, $r = -0.70^{**}$ for SY vs DI and $r = 0.68^{**}$ for SY vs %R.

Although by harvest the roots were heavily infested with cyst nematode, this did not appear to cause a differential response (yield) and infection centers were not apparent nor were the usual foliar symptoms (wilting and stunting) to nematode infestation. Powdery mildew was controlled with Bayleton. Root rot was caused by Erwinia. No other disease or pests appeared to be important.

Replications 5-8 were grown under moderate rhizomania conditions adjacent to replications 1-4. The inoculation histories of 4595-1 and 4595-2 were different. Test 4595-1 was inoculated in 1993. Infested soil was spread over the area and sugarbeets were grown from September to November, then disced under. In 1994, sugarbeet was grown from May to August and then disced under. For Test 4595-2, infested soil was broadcast over the area in 1994 and sugarbeets grown from August to November, then disced under. Starting in November 1994, these adjacent areas were farmed as a single unit receiving the same cultural practices and inputs.

TEST 4595-1. WS/HG RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

32 entries x 4 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 23, 1995

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
		Sugar Lbs	Beets Tons				DI	%R
Beta 4006	(Beta 2J0179)	5571	21.00	108	0.0	75.9	3.8	54.8
Beta 4J0197	Betaseed	7952	28.24	159	0.0	77.0	3.7	59.8
HM 1632	Hilleshog-MH	6699	26.49	150	0.0	77.0	3.9	53.7
HM 1633	Hilleshog-MH	6326	25.44	156	0.0	76.2	3.8	57.8
Rhizosen	Holly	4484	18.08	158	0.0	79.7	4.3	43.5
95 HX326	Holly	5984	23.45	153	0.0	76.8	3.7	63.2
Kojak	Seedex	6856	26.37	149	0.0	78.0	3.8	59.6
SX 0216	Seedex	5251	22.17	151	0.0	76.7	3.9	54.3
H92505	Spreckels	5963	23.16	129	0.0	77.4	4.3	43.8
H93861	Spreckels	5985	22.69	154	0.0	76.3	4.0	52.3
H93694	Spreckels	7056	30.45	160	0.0	76.7	3.7	62.9
HH50	Holly	4194	18.55	166	0.0	78.0	4.3	39.3
ACH 203	Amer. Crystal	5321	22.81	171	0.0	76.7	4.1	46.3
Monohikari	Seedex check	4891	18.78	163	0.0	79.2	4.4	37.4
Maribo 9372	Maribo	6375	22.58	155	0.0	77.0	3.7	61.9
Beta 2J0152	Betaseed	8159	30.45	146	0.0	75.1	3.5	70.1
95HX326	Holly	4566	17.21	149	0.0	77.5	3.8	62.4
Beta 3BG6328	Betaseed	6600	22.13	99	4.1	79.4	3.7	65.1
Rhizosen CT	Holly	5772	25.44	156	0.0	74.7	4.3	42.1
95 HX329	Holly	5578	24.08	158	0.0	76.4	3.7	63.2
H93478	Spreckels	4288	18.14	151	0.0	75.6	4.6	34.6
HM 1815	Hilleshog-MH	6054	25.49	159	0.0	76.1	3.3	72.4
Rhizosen Plus	Holly	7144	26.43	143	0.0	77.6	3.9	56.8
Rival	Holly	7403	27.48	144	0.0	75.5	3.6	64.2
93HX120	Holly	5060	22.11	145	0.0	78.6	4.0	52.1
95HX310	Holly	6039	25.38	158	0.8	75.5	3.4	75.6
95HX317	Holly	6093	23.39	151	1.7	76.6	3.7	67.0
FD 9516	Desprez(F-M), 2-21-95	7170	30.74	160	0.0	74.1	3.6	69.0

TEST 4595-1. WS/HG RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
		Sugar Lbs	Beets Tons				DI	%R
US H11	11-16-94	3062	14.82	10.27	0.0	79.0	4.4	36.7
Rizor	RZ3/1022 (1-21-93)	7248	24.68	14.66	0.0	74.9	3.7	61.9
R422R4H52	F92-790-15H52 x RZM R422R4,% 6908		31.97	10.79	0.0	73.6	3.7	62.4
4918H52	F92-790-15H52 x RZM 3918 6409		27.94	11.50	0.0	76.2	3.8	62.3
Mean		6014.4	24.00	12.53	0.2	76.7	3.9	56.5
LSD (.05)		712.8	2.71	0.52	1.2	2.3	0.4	12.1
C.V. (%)		11.9	11.35	4.13	595.9	3.0	8.9	21.5
F value		10.4**	9.50**	18.72**	1.7*	1.7*	3.3**	3.3**

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Notes: Entries 1 through 27 were submitted by Western Sugar and Holly Growers Seed Evaluation Committees. FD 9516 was submitted by Ferry-Morse Seed Company for Desprez. US H11, Rizor, R422R4H52, and 4918H52 were USDA entries. US H11 is a highly susceptible check. Rizor is a moderately resistant check. R422R4H52 is an experimental hybrid with resistance to rhizomania from C50 (*Beta maritima*). 4918H52 segregates for resistance from Rz (Holly source).

Root rot appeared to be caused by Erwinia.

RJAP = raw juice apparent purity.

Test area was under high nitrogen status and was watered twice per week. Despite rhizomania and cyst nematode, top growth was very good and a differential green vs yellowing due to rhizomania did not occur. Stands were good and except for two entries (numbers 1 and 18), adjustments for gaps were unnecessary.

Replications 1-4 were grown under moderately severe rhizomania conditions. These 4 replications were harvested manually and scored by individual roots for reaction to rhizomania. For 4595-1, the tops were flailed and roots lifted, scored, topped, washed, weighed, and run through the sugar laboratory. For most plots, there were two sugar samples. The individual roots were scored on a scale of 0-9, where 0 = no disease and 9 = dead. Mostly in this test, ratings of 1,3,5, and 7 were used. Ratings of 0-4 were considered resistant and 5-9 susceptible. Based upon US H11, approximately 36% of the roots were escapes or partial escapes. Conversely, because of high cyst nematode infestation, some rhizomania resistant roots were probably scored as susceptible. Thus the rhizomania ratings of DI (disease index) and %R (% resistant) are biased in both directions (by escapes and nematodes). These varietal ratings should not be viewed as precise measurements for frequency of resistant individuals, but as an index of relative reaction to rhizomania. As a comparative relative value, they appear

TEST 4595-1. WS/HG RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
		Sugar Lbs.	Beets Tons				DI	%R
				Sucrose %				

to be good estimates and to fit expectations for known entries. It is still the judgement of the tester (RTL, USDA) that gross sugar yield is the best relative measure of disease reaction when the relative yield of the entries under nonrhizomania conditions also is known in the area of their adaptation. That the overall effects of rhizomania are so important, that within a set of entries of similar performance capacities, that ranking will reflect relative reaction to rhizomania. Even for roots that scored resistant but are actually susceptible, e.g., those of US H11, the tap root may have initially escaped infection and thus severe bearding, but many of the lateral and feeder root (not accounted for when scored) would be infected and fully involved with the disease and thus cause a reduction in sugar yield. The relationship between sugar yield vs DI and sugar yield vs %R was not as high as in the 1994 tests. For Test 4595-1, $r = -0.70^{**}$ for SY vs DI and $r = 0.68^{**}$ for SY vs %R.

Although by harvest the roots were heavily infested with cyst nematode, this did not appear to cause a differential response (yield) and infection centers were not apparent nor were the usual foliar symptoms (wilting and stunting) to nematode infestation. Powdery mildew was controlled with Bayleton. Root rot was caused by Erwinia. No other disease or pests appeared to be important.

TEST 4595-2. WS/HG RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995

32 entries x 4 replications, RCB (equalized)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 30, 1995

Variety	Description	Acre Yield		Beets/ 100'	Bolting	Root	RJAP
		Sugar Lbs	Beets Tons				
Beta 4006	(Beta 2J0179)	8297	28.35	14.63	138	0.9	78.6
Beta 4J0197	Betaseed	9423	30.87	15.25	161	0.0	79.2
HM 1632	Hilleshog-MH	8570	31.82	13.48	169	0.0	77.9
HM 1633	Hilleshog-MH	7993	30.66	13.02	176	0.0	79.0
Rhizosen	Holly	7010	25.73	13.55	176	0.0	81.1
95 HX326	Holly	7827	27.51	14.23	168	0.0	80.4
Kojak	Seedex	8791	31.71	13.85	175	0.0	79.4
SX 0216	Seedex	6884	26.46	13.00	165	0.0	78.9
H92505	Spreckels	8558	30.77	13.95	165	0.0	80.5
H93861	Spreckels	7391	27.20	13.60	183	0.0	78.6
H93694	Spreckels	8900	33.08	13.45	175	0.0	79.5
HH50	Holly	6727	26.36	12.75	180	0.0	78.2
ACH 203	Amer. Crystal	6396	24.89	12.88	180	0.0	79.1
Monohikari	Seedex check	6169	22.26	13.88	183	0.0	80.7
Maribo 9372	Maribo	8009	28.88	13.88	181	0.0	77.2
Beta 2J0152	Betaseed	10275	35.70	14.40	176	0.0	78.7
95HX326	Holly	8232	28.63	14.38	165	0.0	78.1
Beta 3BG6328	Betaseed	9079	30.60	14.85	101	0.0	78.4
Rhizosen CT	Holly	7894	29.51	13.38	169	0.0	79.6
95 HX329	Holly	7680	29.00	13.23	155	0.0	79.6
H93478	Spreckels	7376	27.51	13.40	165	0.0	80.7
HM 1815	Hilleshog-MH	7909	29.93	13.23	185	0.0	78.2
Rhizosen Plus	Holly	8320	30.35	13.75	164	0.0	78.7
Rival	Holly	8731	30.66	14.23	174	0.0	77.4
93HX120	Holly	6299	24.26	12.98	179	0.0	81.6
95HX310	Holly	8049	31.50	12.77	161	0.0	77.5
95HX317	Holly	7840	27.72	14.15	176	0.0	78.9
FD 9516	Desprez(Ferry-Morse), 2-21-95	8196	32.13	12.75	165	0.0	75.7

TEST 4595-2. WS/HG RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Bolting %	Root %	RJAP %
		Sugar Lbs	Beets Tons				
US H11	11-16-94	5378	22.78	11.75	0.0	0.0	77.1
Rizor	R23/1022 (1-21-93)	8967	29.82	15.02	0.0	0.0	75.4
R422R4H52	F92-790-15H52 x RZM R422R4, %	9205	36.96	12.45	0.0	1.5	76.2
4918H52	F92-790-15H52 x RZM 3918	8102	32.13	12.63	0.0	0.0	79.1
Mean		7952.4	29.24	13.58	0.0	0.2	78.7
LSD (.05)		674.2	2.36	0.48	0.3	1.0	0.3
C.V. (%)		8.5	8.10	3.55	9.0	472.3	0.4
F value		9.6**	7.82**	11.05**	4.3**	1.0NS	91.9**

Notes: Entries 1 through 27 were submitted by Western Sugar and Holly Growers Seed Evaluation Committees. FD 9516 was submitted by Ferry-Morse Seed Company for Desprez. US H11, Rizor, R422R4H52, and 4918H52 were USDA entries. US H11 is a highly susceptible check. Rizor is a moderately resistant check. R422R4H52 is an experimental hybrid with resistance to rhizomania from C50 (*Beta maritima*). 4918H52 segregates for resistance from R₂ (Holly source).

Root rot appeared to be caused by Erwinia.

RJAP = raw juice apparent purity.

Test area was under high nitrogen status and was watered twice per week. Despite rhizomania and cyst nematode, top growth was very good and a differential green vs yellowing due to rhizomania did not occur. Stands were good and except for two entries (numbers 1 and 18), adjustments for gaps were unnecessary.

Replications 5-8 were grown under moderate rhizomania conditions adjacent to replications 1-4. The inoculation histories of 4595-1 and 4595-2 were different. Test 4595-1 was inoculated in 1993. Infested soil was spread over the area and sugarbeets were grown from September to November, then disced under. In 1994, sugarbeet was grown from May to August and then disced under. For Test 4595-2, infested soil was broadcast over the area in 1994 and sugarbeets grown from August to November, then disced under. Starting in November 1994, these adjacent areas were farmed as a single unit receiving the same cultural practices and inputs.

Test 4595-2 (replications 5-8) was not scored for rhizomania and was mechanically harvested. One sugar sample was harvested from each plot. A correlation of $r = 0.86^{**}$ was calculated between Tests 4595-1 vs 4595-2 for gross sugar yield. For %R from 4595-1 vs sugar yield for 4595-2, $r = 0.63^{**}$. For DI from 4595-1 vs sugar yield for 4595-2, $r = -0.62^{**}$. Based upon these values, the means for the 32 entries x 8 replications ANOVA would probably offer the most accurate information.

TEST 4695. CBGA CODED RHIZOMANIA TESTS, SALINAS, CA., 1995

96 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: Oct. 23-25 & 30; Nov. 1, 1995

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
			Sugar Lbs	Beets Tons				DI	%R
					Sucrose %				
1	SS-NB5R	Spreckels	8485	33.05	12.9	0.0	78.1	4.3	33.2
2	3BG6225	Betaseed	7779	28.30	13.7	0.0	77.6	4.0	52.2
3	H945187	Spreckels	7412	28.89	12.8	0.0	78.3	3.9	57.8
4	Rhizosen Plus	Holly	7849	29.66	13.2	1.6	79.0	4.2	43.7
5	BTS-1	Betaseed	8503	32.03	13.3	0.0	78.8	4.2	43.9
6	95HX12	Holly	8438	30.17	14.0	0.0	79.0	4.1	47.8
7	SS-287R	Spreckels	6251	24.95	12.5	0.0	78.6	4.5	38.8
8	4CG6592	Betaseed	5896	22.91	12.9	0.0	80.2	4.7	24.6
9	BTS-2	Betaseed	8091	30.47	13.3	0.0	78.7	4.3	39.5
10	3KJ5128	Betaseed	8847	33.22	13.3	0.0	78.3	4.0	50.5
11	Rhizoguard CT	Holly	6650	26.81	12.2	0.0	79.6	4.8	17.3
12	HM 3053	Hilleshog	7639	30.22	12.6	0.0	79.0	4.4	37.6
13	BTS-3	Betaseed	8686	32.67	13.3	0.0	77.1	4.3	39.8
14	4KJ0169	Betaseed	8599	32.06	13.4	0.0	78.0	4.2	42.4
15	H93432	Spreckels	7283	27.07	13.4	0.0	78.8	4.5	28.4
16	BTS-4	Betaseed	7670	29.70	12.9	0.0	79.2	4.4	40.3
17	95HX09	Holly	8359	30.63	13.7	3.2	77.7	3.9	57.5
18	BTS-5	Betaseed	7707	27.66	14.1	0.0	78.8	3.8	57.7
19	2J5088	Betaseed	9730	34.77	14.0	0.0	78.2	4.0	51.0
20	94HX22	Holly	7117	28.61	12.5	0.0	77.6	3.9	54.9
21	SS-NB2R2	Spreckels	8009	31.94	12.5	0.0	77.3	4.1	47.1
22	HM 3042	Hilleshog	8480	31.69	13.4	0.0	78.8	4.1	48.8
23	H93747	Spreckels	7606	28.74	13.2	0.0	78.2	3.8	60.5
24	HH-102R	Holly	7652	28.40	13.4	0.0	79.5	4.4	34.3
25	Rhizoguard	Holly	6505	25.47	12.8	0.0	78.7	3.9	55.3
26	95HX15	Holly	6326	26.16	12.0	0.0	78.0	4.1	49.0
27	SS-595R	Spreckels	6577	25.01	13.1	0.0	79.1	4.0	50.3
28	H944178	Spreckels	8177	31.53	12.9	0.0	78.3	3.7	65.2

TEST 4695. CBGA CODED RHIZOMANIA TESTS, SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
			Sugar Lbs	Beets Tons				DI	%R
			Sucrose %		No.	%	%		
29	HH-97R	Holly	5607	22.68	158	0.0	78.3	4.8	26.5
30	4KJ0164	Betaseed	9628	38.68	173	0.0	78.1	3.3	80.4
31	4CG6574	Betaseed	8413	29.66	93	0.0	78.2	4.0	45.9
32	3BG6212	Betaseed	9189	32.31	95	0.0	77.7	4.0	50.2
33	HH-101R	Holly	7314	29.58	151	0.0	78.3	4.4	36.3
34	HM 3051	Hilleshog	6647	24.79	169	0.0	76.8	4.3	40.7
35	HM 3047	Hilleshog	7320	28.28	151	0.0	77.1	4.0	49.9
36	4KJ5145	Betaseed	9031	33.27	136	0.0	79.3	4.0	52.6
37	US H11	USDA	4369	20.28	166	0.0	79.0	4.8	23.8
38	4CG6583	Betaseed	8218	29.53	138	0.0	79.5	4.1	45.1
39	H92326	Spreckels	8208	32.08	161	0.0	78.3	4.0	47.1
40	4CG6580	Betaseed	8848	31.17	144	0.0	77.3	3.8	59.7
41	SS-781R	Spreckels	7659	29.37	151	0.0	79.5	4.2	44.1
42	HM 3027	Hilleshog	7617	29.60	166	0.0	78.0	3.8	62.5
43	2J0152	Betaseed	9462	35.30	128	0.0	77.5	3.9	56.0
44	94HX34	Holly	7951	29.05	153	0.9	79.4	4.0	52.4
45	SS-IV3	Spreckels	6366	26.08	162	0.0	79.0	4.0	50.2
46	HM 3052	Hilleshog	8091	32.04	158	0.0	78.2	3.9	58.8
47	Rizor	USDA	8791	29.27	163	0.6	78.1	4.0	51.6
48	4CG6596	Betaseed	9203	34.89	103	0.0	77.9	4.1	45.4
49	94HX30	Holly	7700	29.57	150	0.0	78.3	4.0	52.4
50	95HX10	Holly	6859	25.01	156	0.0	80.0	3.9	59.1
51	6770	USDA	4979	18.98	151	0.0	80.2	4.9	17.0
52	94HX04	Holly	5468	22.44	159	0.0	80.6	5.0	15.6
53	SS-289R	Spreckels	6674	25.43	160	0.0	78.1	4.3	44.9
54	94HX32	Holly	6216	25.49	163	0.0	80.1	4.2	46.7
55	95HX19	Holly	7143	26.45	154	0.0	79.5	4.0	50.6
56	Rhizosen CT	Holly	7405	28.64	152	0.0	79.3	4.4	36.4
57	HM 3050	Hilleshog	7739	31.13	151	0.0	77.1	3.8	63.0
58	US H11	USDA check	4595	21.20	161	0.0	77.4	4.9	23.5
59	HM 3026	Hilleshog	8667	32.50	158	0.0	78.2	4.2	42.6
60	H91609	Spreckels	6822	26.01	174	0.0	78.1	4.4	37.7

TEST 4695. CBGA CODED RHIZOMANIA TESTS, SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
			Sugar Lbs	Beets Tons				DI	%R
					Sucrose %				
61	4454	USDA	5842	23.47	12.4	0.0	76.9	4.7	25.4
62	95HX13	Holly	7124	29.42	12.1	0.0	78.8	4.1	48.2
63	HM 3054	Hilleshog	7181	26.54	13.5	0.0	79.0	4.2	44.0
64	95HX16	Holly	8060	30.92	13.0	0.0	78.8	4.0	48.5
65	2J0179	Betaseed	8662	28.44	15.2	0.0	78.3	3.9	54.4
66	US H11	USDA	4785	20.74	11.5	0.0	80.4	4.8	26.9
67	3BG6224	Betaseed	8906	30.65	14.5	0.0	77.7	4.0	50.2
68	2J5324	Betaseed	8283	30.51	13.6	0.0	78.2	4.1	50.5
69	Beta 4581	Betaseed	8610	32.35	13.3	0.0	76.6	3.9	55.7
70	94HX33	Holly	7940	29.98	13.2	0.0	79.5	4.1	51.3
71	Rival	Holly	8419	30.11	13.9	0.0	78.5	3.8	61.0
72	3BG6226	Betaseed	8039	28.66	14.1	0.0	77.9	3.9	54.3
73	H92372	Spreckels	7255	27.39	13.2	0.0	79.2	4.4	40.9
74	4CG6585	Betaseed	7118	28.12	12.6	0.0	77.8	4.0	54.7
75	H93694	Spreckels	8530	34.17	12.5	0.0	77.1	3.9	56.6
76	90-88C11-09	Holly	7750	28.85	13.5	0.0	78.9	3.9	56.3
77	R480-45H50	USDA	8897	32.91	13.5	0.0	77.4	3.8	63.0
78	4CG6549	Betaseed	7235	28.21	12.7	0.0	78.4	4.4	36.3
79	4911-4H50	USDA	8143	30.04	13.4	0.0	79.3	3.9	56.0
80	H92635	Spreckels	7594	28.83	13.2	0.0	78.3	3.9	56.9
81	4915H50	USDA	7974	30.78	12.9	0.0	78.4	4.1	48.9
82	94HX05	Holly	7932	29.48	13.4	0.0	79.5	4.1	49.5
83	4918H50	USDA	7929	31.27	12.6	0.0	78.6	4.2	43.6
84	H92366	Spreckels	7593	28.72	13.2	0.0	78.4	4.1	48.2
85	94HX31	Holly	8218	30.67	13.4	0.0	78.9	4.2	42.3
86	95HX11	Holly	7154	25.04	14.3	0.0	79.1	4.1	47.6
87	3BG6384	Betaseed	7877	31.30	12.5	0.0	78.2	3.9	54.5
88	95HX14	Holly	8041	29.90	13.5	0.0	80.1	3.9	54.5
89	H93431	Spreckels	8735	32.47	13.5	0.0	79.1	3.8	61.0
90	HM 3048	Hilleshog	7491	27.97	13.4	0.0	78.1	4.0	57.5
91	Rhizosen	Holly	7242	28.69	12.6	0.0	79.7	4.1	53.6
92	3BG6170	Betaseed	7913	30.11	13.1	0.0	78.0	4.1	48.6

TEST 4695. CBGA CODED RHIZOMANIA TESTS, SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
			Sugar	Beets				DI	%R
			Lbs	Tons					
93	R422R4H50	USDA	8073	31.69	168	0.0	77.0	3.9	55.3
94	R422Y3H15	USDA	8113	30.16	161	0.0	78.5	3.8	60.7
95	R440H50	USDA	6685	25.72	167	0.0	78.5	4.3	42.9
96	R479H50	USDA	7158	27.88	169	0.0	78.2	4.1	48.6
Mean			7635.7	29.02	152.7	0.1	78.5	4.1	47.4
LSD (.05)			916.0	3.50	14.7	0.6	2.1	0.5	20.8
C.V. (%)			12.2	12.29	9.8	603.2	2.8	8.1	31.6
F value			10.6**	7.41**	10.7**	3.6**	1.2NS	3.2**	2.4**

NOTES: Entries 1-92 were submitted by the California Seed Evaluation Committee except for entries 5,9,13,16, and 18 which were from Betaseed, and entries 37,47,51,61,66,77,79,81,83,93,94,95, and 96 which were from USDA. US H11, 4454, and 6770 are susceptible checks. Rizor is a moderately resistant check. The other USDA entries are experimental hybrids that segregate for resistance to rhizomania.

Root rot appeared to be caused by Erwinia.

RJAP = raw juice apparent purity.

Test area was under high nitrogen status and was watered twice per week with sprinkler irrigation. Despite rhizomania and cyst nematode, top growth was very good and a differential green vs yellowing due to rhizomania did not occur. Stands were good except for a few entries. For entries with low stands, as necessary, adjustments for yield were made based upon missing feet of row.

Replications 1-4 were grown under moderately severe rhizomania conditions. These 4 replications were harvested manually and scored by individual roots for reaction to rhizomania. For 4695-1, the tops were flailed and roots lifted, scored, topped, washed, weighed, and run through the sugar laboratory. For most plots, there were two sugar samples. The individual roots were scored on a scale of 0-9, where 0 = no disease and 9 = dead. Mostly in this test, ratings of 1,3,5, and 7 were used. Ratings of 0-4 were considered resistant and 5-9 susceptible. Based upon US H11, approximately 25% of the roots were escapes or partial escapes. Conversely, because of high cyst nematode infestation, some rhizomania resistant roots were probably scored as susceptible. Thus the rhizomania ratings of DI (disease index) and %R (% resistant) are biased in both directions (by escapes and nematodes). These varietal ratings should not be viewed as precise measurements for frequency of resistant individuals, but as an index of relative reaction to rhizomania. As a comparative relative value, they appear to be good estimates and to fit expectations for known entries. It is still the judgement of the tester (RTL, USDA) that gross sugar yield is the best relative measure of disease reaction when the relative yield of the entries under nonrhizomania conditions also is known in the area of their adaptation. That the overall effects

TEST 4695. CBGA CODED RHIZOMANIA TESTS, SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	RJAP %	RZM Resistance	
			Sugar Lbs	Beets Tons				DI	%R
					Sucrose %				

of rhizomania are so important, that within a set of entries of similar performance capacities, that ranking will reflect relative reaction to rhizomania. Even for roots that scored resistant but are actually susceptible, e.g., those of US H11, the tap root may have initially escaped infection and thus severe bearding, but many of the lateral and feeder root (not accounted for when scored) would be infected and fully involved with the disease and thus cause a reduction in sugar yield. The relationship between sugar yield vs DI and sugar yield vs %R was not as high as in the 1994 tests. For Test 4695-1, $r = -0.67^{**}$ for SY vs DI and $r = 0.59^{**}$ for SY vs %R.

Although by harvest the roots were heavily infested with cyst nematode, this did not appear to cause a differential response (yield) and infection centers were not apparent nor were the usual foliar symptoms (wilting and stunting) to nematode infestation. Powdery mildew was controlled with Bayleton. Root rot was caused by Erwinia. No other disease or pests appeared to be important.

Replications 5-8 were grown under moderate rhizomania conditions adjacent to replications 1-4. The inoculation histories of 4695-1 and 4695-2 were different. Test 4695-1 was inoculated in 1993. Infested soil was spread over the area and sugarbeets were grown from September to November, then disced under. In 1994, sugarbeet was grown from May to August and then disced under. For Test 4695-2, infested soil was broadcast over the area in 1994 and sugarbeets grown from August to November, then disced under. Starting in November 1994, these adjacent areas were farmed as a single unit receiving the same cultural practices and inputs.

TEST 4695-1. CBGA CODED RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

96 entries x 4 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 23-25, 1995

Code	Variety	Company	Acre Yield		Beets/ 100'	RJAP %	Powdery Mildew Score	RZM Resistance	
			Sugar Lbs	Beets Tons				DI	%R
1	SS-NB5R	Spreckels	8376	32.91	12.71	78.3	3.5	4.3	33.2
2	3BG6225	Betaseed	6603	24.83	13.27	76.3	3.3	4.0	52.2
3	H945187	Spreckels	6279	25.55	12.30	77.4	3.3	3.9	57.8
4	Rhizosen Plus	Holly	7255	28.24	12.86	78.1	3.5	4.2	43.7
5	BTS-1	Betaseed	7581	29.40	12.93	79.1	2.5	4.2	43.9
6	95HX12	Holly	7170	25.38	14.18	78.0	3.0	4.1	47.8
7	SS-287R	Spreckels	5177	21.76	11.99	78.4	3.8	4.5	38.8
8	4CG6592	Betaseed	4710	18.20	12.99	80.1	3.3	4.7	24.6
9	BTS-2	Betaseed	6851	26.19	13.18	77.7	3.5	4.3	39.5
10	3KJ5128	Betaseed	7445	27.83	13.35	77.3	2.5	4.0	50.5
11	Rhizoguard CT	Holly	5979	24.89	11.57	79.1	3.3	4.8	17.3
12	HM 3053	Hilleshog	6692	27.89	12.00	77.2	3.5	4.4	37.6
13	BTS-3	Betaseed	7934	30.28	13.10	77.0	3.3	4.3	39.8
14	4KJ0169	Betaseed	7296	27.36	13.35	77.4	3.5	4.2	42.4
15	H93432	Spreckels	5603	21.70	12.96	76.7	3.0	4.5	28.4
16	BTS-4	Betaseed	6288	26.42	12.26	79.1	2.8	4.4	40.3
17	95HX09	Holly	7476	27.77	13.57	77.7	3.3	3.9	57.5
18	BTS-5	Betaseed	6044	22.26	14.05	77.8	3.3	3.8	57.7
19	2J5088	Betaseed	9238	32.49	14.21	78.4	3.0	4.0	51.0
20	94HX22	Holly	6448	25.69	12.59	78.3	3.3	3.9	54.9
21	SS-NB2R2	Spreckels	7365	29.75	12.38	76.2	3.0	4.1	47.1
22	HM 3042	Hilleshog	7706	29.05	13.30	77.9	3.0	4.1	48.8
23	H93747	Spreckels	6369	24.91	12.84	77.1	2.8	3.8	60.5
24	HH-102R	Holly	6954	26.25	13.24	78.9	4.3	4.4	34.3
25	Rhizoguard	Holly	5949	23.74	12.51	78.5	3.3	3.9	55.3
26	95HX15	Holly	5350	22.93	11.66	77.9	3.3	4.1	49.0
27	SS-595R	Spreckels	5587	22.40	12.55	78.5	3.8	4.0	50.3
28	H944178	Spreckels	7002	28.94	12.15	76.9	3.8	3.7	65.2

TEST 4695-1. CBGA CODED RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	RJAP %	Powdery Mildew Score	RZM Resistance	
			Sugar Lbs	Beets Tons				DI	%R
29	HH-97R	Holly	4939	20.42	12.10	77.7	3.0	4.8	26.5
30	4KJ0164	Betaseed	8143	33.89	12.09	77.1	4.3	3.3	80.4
31	4CG6574	Betaseed	7981	28.22	14.14	77.6	3.3	4.0	45.9
32	3BG6212	Betaseed	8610	29.94	14.39	76.2	3.5	4.0	50.2
33	HH-101R	Holly	5757	24.20	12.06	76.8	3.5	4.4	36.3
34	HM 3051	Hilleshog	5243	20.07	13.11	76.0	3.5	4.3	40.7
35	HM 3047	Hilleshog	6281	24.73	2.75	76.2	3.8	4.0	49.9
36	4KJ5145	Betaseed	8148	30.63	13.30	78.6	3.3	4.0	52.6
37	US H11	USDA	3720	18.51	9.88	78.1	3.3	4.8	23.8
38	4CG6583	Betaseed	6211	23.03	13.51	78.2	3.8	4.1	45.1
39	H92326	Spreckels	6805	27.83	12.23	77.5	3.3	4.0	47.1
40	4CG6580	Betaseed	7808	28.64	13.65	75.2	3.5	3.8	59.7
41	SS-781R	Spreckels	6832	27.67	12.38	77.8	3.5	4.2	44.1
42	HM 3027	Hilleshog	6594	26.54	12.51	78.0	3.5	3.8	62.5
43	2J0152	Betaseed	9015	34.03	13.26	78.2	4.3	3.9	56.0
44	94HX34	Holly	6917	25.96	13.40	78.7	3.5	4.0	52.4
45	SS-IV3	Spreckels	5324	22.75	11.75	77.5	3.0	4.0	50.2
46	HM 3052	Hilleshog	6801	28.06	12.13	77.3	3.8	3.9	58.8
47	Rizor	USDA	8002	27.36	14.65	77.4	3.8	4.0	51.6
48	4CG6596	Betaseed	7391	28.34	13.07	77.0	3.3	4.1	45.4
49	94HX30	Holly	7209	27.54	13.06	78.7	4.0	4.0	52.4
50	95HX10	Holly	6024	22.58	13.38	79.0	4.0	3.9	59.1
51	6770	USDA	3789	14.23	13.57	80.1	3.3	4.9	17.0
52	94HX04	Holly	4167	18.20	11.41	81.5	3.5	5.0	15.6
53	SS-289R	Spreckels	6088	24.09	12.63	77.7	2.8	4.3	44.9
54	94HX32	Holly	5567	24.05	11.73	79.7	3.0	4.2	46.7
55	95HX19	Holly	6904	26.25	13.18	80.1	3.0	4.0	50.6
56	Rhizosen CT	Holly	6541	26.84	12.19	77.0	3.3	4.4	36.4
57	HM 3050	Hilleshog	6551	27.30	12.01	77.0	3.3	3.8	63.0
58	US H11	USDA check	3561	18.32	9.69	75.2	3.5	4.9	23.5
59	HM 3026	Hilleshog	7681	30.04	12.80	77.3	3.8	4.2	42.6
60	H91609	Spreckels	5157	20.94	12.34	76.2	3.3	4.4	37.7

TEST 4695-1. CBGA CODED RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	RJAP %	Powdery Mildew		RZM Resistance		
			Sugar Lbs	Beets Tons			Sucrose %	No.	Score	DI	%R
61	4454	USDA	4762	19.54	12.21	75.6	3.8	4.7	25.4		
62	95HX13	Holly	6488	28.18	11.50	78.4	4.0	4.1	48.2		
63	HM 3054	Hilleshog	6188	23.04	13.40	77.8	3.3	4.2	44.0		
64	95HX16	Holly	7082	27.83	12.71	78.4	2.8	4.0	48.5		
65	2J0179	Betaseed	8157	26.78	15.23	77.9	3.0	3.9	54.4		
66	US H11	USDA	3751	16.92	11.20	80.2	3.0	4.8	26.9		
67	3BG6224	Betaseed	8244	28.70	14.38	78.1	3.5	4.0	50.2		
68	2J5324	Betaseed	7985	30.16	13.24	78.5	3.5	4.1	50.5		
69	Beta 4581	Betaseed	7469	29.11	12.84	75.5	3.5	3.9	55.7		
70	94HX33	Holly	6925	26.72	12.94	79.1	3.8	4.1	51.3		
71	Rival	Holly	7596	27.89	13.61	76.8	3.8	3.8	61.0		
72	3BG6226	Betaseed	7166	25.26	14.26	77.6	4.0	3.9	54.3		
73	H92372	Spreckels	6359	24.79	12.79	76.8	3.3	4.4	40.9		
74	4CG6585	Betaseed	5529	23.28	11.96	77.2	4.0	4.0	54.7		
75	H93694	Spreckels	7723	32.32	11.95	77.3	3.3	3.9	56.6		
76	90-88C11-09	Holly	7047	27.77	12.76	76.7	2.5	3.9	56.3		
77	R480-45H50	USDA	8057	31.27	12.85	75.4	3.0	3.8	63.0		
78	4CG6549	Betaseed	5486	22.97	12.00	77.2	3.0	4.4	36.3		
79	4911-4H50	USDA	5944	22.81	12.88	78.9	2.8	3.9	56.0		
80	H92635	Spreckels	7129	27.94	12.75	77.2	3.5	3.9	56.9		
81	4915H50	USDA	6767	27.54	12.27	78.0	4.0	4.1	48.9		
82	94HX05	Holly	7057	27.36	12.88	78.4	3.3	4.1	49.5		
83	4918H50	USDA	6339	25.67	12.34	77.8	3.5	4.2	43.6		
84	H92366	Spreckels	6919	27.30	12.66	77.6	3.3	4.1	48.2		
85	94HX31	Holly	7467	28.59	13.10	77.8	3.8	4.2	42.3		
86	95HX11	Holly	5870	20.88	14.10	78.1	2.8	4.1	47.6		
87	3BG6384	Betaseed	6598	27.24	12.07	76.6	3.3	3.9	54.5		
88	95HX14	Holly	7431	28.06	13.28	80.5	3.5	3.9	54.5		
89	H93431	Spreckels	8193	31.44	13.05	79.2	3.0	3.8	61.0		
90	HM 3048	Hilleshog	6672	26.02	12.83	76.6	3.5	4.0	57.5		
91	Rhizosen	Holly	6216	26.37	11.78	78.5	3.3	4.1	53.6		
92	3BG6170	Betaseed	7459	29.34	12.70	77.4	4.0	4.1	48.6		

TEST 4695-1. CBGA CODED RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Sucrose %	No.	RJAP %	Powdery Mildew		RZM Resistance	
			Sugar Lbs	Beets Tons					Score	DI	%R	
93	R422R4H50	USDA	7394	29.99		12.36	155	76.5	2.8		3.9	55.3
94	R422Y3H15	USDA	7048	27.24		12.91	148	76.7	3.0		3.8	60.7
95	R440H50	USDA	5403	21.23		12.74	171	78.0	3.3		4.3	42.9
96	R479H50	USDA	6135	24.79		12.41	174	77.6	4.3		4.1	48.6
Mean			6670.7	26.10		12.76	149.9	77.8	3.7		4.1	47.4
LSD (.05)			1342.4	5.42		0.93	22.1	3.1	1.0		0.5	20.8
C.V. (%)			14.5	14.92		5.21	10.6	2.9	20.3		8.1	31.6
F value			5.9**	3.83**		6.99	5.7**	1.1NS	1.4*		3.2**	2.4**

NOTES: Entries 1-92 were submitted by the California Seed Evaluation Committee except for entries 5,9,13,16, and 18 which were from Betaseed, and entries 37,47,51,61,66,77,79,81,83,93,94,95, and 96 which were from USDA. US H11, 4454, and 6770 are susceptible checks. Rizer is a moderately resistant check. The other USDA entries are experimental hybrids that segregate for resistance to rhizomania.

Root rot appeared to be caused by Erwinia.

RJAP = raw juice apparent purity.

Test area was under high nitrogen status and was watered twice per week with sprinkler irrigation. Despite rhizomania and cyst nematode, top growth was very good and a differential green vs yellowing due to rhizomania did not occur. Stands were good except for a few entries. For entries with low stands, as necessary, adjustments for yield were made based upon missing feet of row.

Replications 1-4 were grown under moderately severe rhizomania conditions. These 4 replications were harvested manually and scored by individual roots for reaction to rhizomania. For 4695-1, the tops were flailed and roots lifted, scored, topped, washed, weighed, and run through the sugar laboratory. For most plots, there were two sugar samples. The individual roots were scored on a scale of 0-9, where 0 = no disease and 9 = dead. Mostly in this test, ratings of 1,3,5, and 7 were used. Ratings of 0-4 were considered resistant and 5-9 susceptible. Based upon US H11, approximately 25% of the roots were escapes or partial escapes. Conversely, because of high cyst nematode infestation, some rhizomania resistant roots were probably scored as susceptible. Thus the rhizomania ratings of DI (disease index) and %R (% resistant) are biased in both directions (by escapes and nematodes). These varietal ratings should not be viewed as precise measurements for frequency of resistant individuals, but as an index of relative reaction to rhizomania. As a comparative relative value, they appear to be good estimates and to fit expectations for known entries. It is still the judgement of the tester (RTL, USDA) that gross sugar yield is the best relative measure of disease reaction when the relative yield of the entries under nonrhizomania conditions also is known in the area of their adaptation. That the overall effects

TEST 4695-1. CBGA CODED RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Sucrose %	RJAP %	Powdery Mildew		RZM Resistance DI	%R
			Sugar Lbs	Beets Tons				Score			

of rhizomania are so important, that within a set of entries of similar performance capacities, that ranking will reflect relative reaction to rhizomania. Even for roots that scored resistant but are actually susceptible, e.g., those of US H11, the tap root may have initially escaped infection and thus severe bearding, but many of the lateral and feeder root (not accounted for when scored) would be infected and fully involved with the disease and thus cause a reduction in sugar yield. The relationship between sugar yield vs DI and sugar yield vs %R was not as high as in the 1994 tests. For Test 4695-1, $r = -0.67^{**}$ for SY vs DI and $r = 0.59^{**}$ for SY vs %R.

Although by harvest the roots were heavily infested with cyst nematode, this did not appear to cause a differential response (yield) and infection centers were not apparent nor were the usual foliar symptoms (wilting and stunting) to nematode infestation. Powdery mildew was controlled with Bayleton. Root rot was caused by Erwinia. No other disease or pests appeared to be important.

TEST 4695-2. CBGA CODED RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995

96 entries x 4 replications, RCB
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: Oct. 30; Nov. 1, 1995

Code	Variety	Company	Acre Yield		Sucrose %	Beets/ 100' No.	Bolting %	Root Rot %	RJAP %
			Sugar Lbs.	Beets Tons					
1	SS-NB5R	Spreckels	8593	33.18	13.00	146	0.0	0.9	77.9
2	3BG6225	Betaseed	8715	30.83	14.15	128	0.0	1.1	79.0
3	H945187	Spreckels	8544	32.24	13.27	158	0.0	0.0	79.2
4	Rhizosen Plus	Holly	8443	31.08	13.63	154	1.6	0.8	79.8
5	BTS-1	Betaseed	9425	34.65	13.57	165	0.0	0.7	78.4
6	95HX12	Holly	9706	34.97	13.88	154	0.0	0.0	80.0
7	SS-287R	Spreckels	7325	28.14	13.00	169	0.0	0.0	78.8
8	4CG6592	Betaseed	7081	27.62	12.82	153	0.0	0.0	80.3
9	BTS-2	Betaseed	9331	34.76	13.43	158	0.0	0.0	79.7
10	3KJ5128	Betaseed	9812	36.97	13.30	111	0.0	2.3	79.3
11	Rhizoguard CT	Holly	7396	28.98	12.75	159	0.0	0.9	80.2
12	HM 3053	Hilleshog	8587	32.55	13.18	164	0.0	0.0	80.8
13	BTS-3	Betaseed	9437	35.07	13.48	159	0.0	0.0	77.2
14	4KJ0169	Betaseed	9901	36.75	13.48	189	0.0	0.0	78.6
15	H93432	Spreckels	8964	32.45	13.80	165	0.0	0.0	80.8
16	BTS-4	Betaseed	8841	32.79	13.48	154	0.0	0.0	79.3
17	95HX09	Holly	9242	33.50	13.80	158	3.2	0.0	77.7
18	BTS-5	Betaseed	9193	32.44	14.17	148	0.0	0.0	79.8
19	2J5088	Betaseed	10110	36.65	13.85	136	0.0	0.0	78.0
20	94HX22	Holly	7504	30.35	12.35	121	0.0	0.0	76.8
21	SS-NB2R2	Spreckels	8654	34.13	12.70	155	0.0	0.0	78.4
22	HM 3042	Hilleshog	9255	34.34	13.48	158	0.0	0.0	79.7
23	H93747	Spreckels	8843	32.57	13.60	153	0.0	0.0	79.2
24	HH-102R	Holly	8350	30.56	13.65	154	0.0	0.0	80.0
25	Rhizoguard	Holly	7060	27.20	13.00	149	0.0	0.0	78.9
26	95HX15	Holly	7303	29.40	12.40	161	0.0	0.0	78.1
27	SS-595R	Spreckels	7567	27.62	13.70	170	0.0	0.0	79.8
28	H944178	Spreckels	9352	34.13	13.70	161	0.0	0.0	79.7

TEST 4695-2. CBGA CODED RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Sucrose %	Beets/ 100'	Bolting %	Root	
			Sugar Lbs	Beets Tons				Rot %	RJAP %
29	HH-97R	Holly	6276	24.95	12.57	156	0.0	0.0	79.0
30	4KJ0164	Betaseed	11114	43.47	12.82	178	0.0	0.0	79.0
31	4CG6574	Betaseed	8488	29.83	14.23	104	0.0	1.3	78.8
32	3BG6212	Betaseed	9769	34.67	14.10	100	0.0	0.0	79.1
33	HH-101R	Holly	8870	34.97	12.68	155	0.0	0.0	79.9
34	HM 3051	Hilleshog	8052	29.51	13.65	170	0.0	0.0	77.7
35	HM 3047	Hilleshog	8359	31.82	13.15	158	0.0	0.0	77.9
36	4KJ5145	Betaseed	9914	35.90	13.90	131	0.0	0.0	80.1
37	US H11	USDA	5017	22.05	11.35	160	0.0	0.0	79.8
38	4CG6583	Betaseed	10138	35.70	14.20	139	0.0	0.0	80.8
39	H92326	Spreckels	9612	36.33	13.23	163	0.0	0.8	79.1
40	4CG6580	Betaseed	9888	33.71	14.68	148	0.0	0.0	79.4
41	SS-781R	Spreckels	8485	31.08	13.65	153	0.0	0.0	81.1
42	HM 3027	Hilleshog	8639	32.66	13.23	169	0.0	0.0	78.0
43	2J0152	Betaseed	10449	38.60	13.55	136	0.0	1.9	76.9
44	94HX34	Holly	8984	32.13	13.98	163	0.9	0.0	80.2
45	SS-IV3	Spreckels	7409	29.40	12.60	166	0.0	0.0	80.5
46	HM 3052	Hilleshog	9382	36.02	13.02	158	0.0	0.0	79.2
47	Rizor	USDA	9579	31.19	15.35	171	0.6	0.0	78.9
48	4CG6596	Betaseed	10733	40.36	13.30	115	0.0	0.0	78.8
49	94HX30	Holly	8192	31.61	13.00	151	0.0	0.0	77.9
50	95HX10	Holly	7694	27.45	14.00	153	0.0	0.0	80.9
51	6770	USDA	6169	23.73	13.02	139	0.0	0.0	80.3
52	94HX04	Holly	6770	26.67	12.70	168	0.0	0.0	79.6
53	SS-289R	Spreckels	7260	26.78	13.55	175	0.0	0.0	78.6
54	94HX32	Holly	6943	27.30	12.65	166	0.0	0.7	80.4
55	95HX19	Holly	7383	26.65	13.85	156	0.0	0.0	78.8
56	Rhizosen CT	Holly	8270	30.45	13.50	153	0.0	0.0	81.6
57	HM 3050	Hilleshog	8926	34.97	12.75	159	0.0	0.0	77.2
58	US H11	USDA check	5629	24.07	11.63	169	0.0	0.0	79.6
59	HM 3026	Hilleshog	9653	34.97	13.82	160	0.0	0.8	79.1
60	H91609	Spreckels	8487	31.08	13.68	176	0.0	0.0	80.0

TEST 4695-2. CBGA CODED RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995
(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	Root Rot %	RJAP %
			Sugar Lbs	Beets Tons				
61	4454	USDA	6922	27.41	12.60	0.0	0.0	78.3
62	95HX13	Holly	7760	30.66	12.67	0.0	0.0	79.2
63	HM 3054	Hilleshog	8173	30.03	13.65	0.0	0.0	80.2
64	95HX16	Holly	9039	34.02	13.30	0.0	0.0	79.3
65	2J0179	Betaseed	9167	30.11	15.23	0.0	0.9	78.7
66	US H11	USDA	5819	24.57	11.85	0.0	0.0	80.7
67	3BG6224	Betaseed	9568	32.61	14.68	0.0	0.0	77.4
68	2J5324	Betaseed	8485	30.49	13.88	0.0	0.0	77.8
69	Beta 4581	Betaseed	9750	35.60	13.70	0.0	0.0	77.7
70	94HX33	Holly	8956	33.25	13.43	0.0	0.0	79.9
71	Rival	Holly	9242	32.34	14.27	0.0	0.0	80.2
72	3BG6226	Betaseed	8819	31.71	13.90	0.0	0.0	78.2
73	H92372	Spreckels	8051	29.61	13.60	0.0	0.0	81.7
74	4CG6585	Betaseed	8707	32.97	13.23	0.0	0.8	78.5
75	H93694	Spreckels	9338	36.02	12.98	0.0	0.0	76.9
76	90-88C11-09	Holly	8454	29.93	14.15	0.0	0.0	81.2
77	R480-45H50	USDA	9736	34.55	14.07	0.0	0.0	79.3
78	4CG6549	Betaseed	8762	32.55	13.48	0.0	0.0	79.5
79	4911-4H50	USDA	10342	37.28	13.88	0.0	0.0	79.7
80	H92635	Spreckels	8060	29.72	13.60	0.0	0.8	79.3
81	4915H50	USDA	9182	34.02	13.50	0.0	0.0	78.7
82	94HX05	Holly	8807	31.61	13.93	0.0	2.3	80.6
83	4918H50	USDA	9518	36.87	12.90	0.0	0.0	79.3
84	H92366	Spreckels	8266	30.14	13.70	0.0	0.0	79.3
85	94HX31	Holly	8970	32.76	13.68	0.0	0.8	80.0
86	95HX11	Holly	8437	29.19	14.45	0.0	0.0	80.1
87	3BG6384	Betaseed	9156	35.36	12.98	0.0	0.0	79.9
88	95HX14	Holly	8652	31.75	13.65	0.0	0.0	79.6
89	H93431	Spreckels	9277	33.50	13.88	0.0	0.0	78.9
90	HM 3048	Hilleshog	8310	29.93	13.90	0.0	0.0	79.6
91	Rhizosen	Holly	8194	30.70	13.35	0.0	0.0	80.8
92	3BG6170	Betaseed	8367	30.87	13.55	0.0	0.0	78.5

TEST 4695-2. CBGA CODED RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995

(cont.)

Code	Variety	Company	Acre Yield		Beets/ 100'	Bolting %	Root %	RJAP %
			Sugar Lbs	Beets Tons				
93	R422R4H50	USDA	8753	33.39	13.10	0.0	0.0	77.5
94	R422Y3H15	USDA	9179	33.08	13.88	0.0	0.0	79.8
95	R440H50	USDA	8369	30.21	13.20	0.0	0.0	79.1
96	R479H50	USDA	8182	30.98	13.20	0.0	0.0	78.9
Mean			8598.3	31.93	13.45	0.1	0.2	79.2
LSD (.05)			1173.0	4.21	0.76	0.6	1.0	3.0
C.V. (%)			9.8	9.47	4.07	9.0	405.3	2.7
F value			6.9**	5.70**	5.74**	3.6**	1.6**	1.0NS

NOTES: Entries 1-92 were submitted by the California Seed Evaluation Committee except for entries 5,9,13,16, and 18 which were from Betaseed, and entries 37,47,51,61,66,77,79,81,83,93,94,95, and 96 which were from USDA. US H11, 4454, and 6770 are susceptible checks. Rizor is a moderately resistant check. The other USDA entries are experimental hybrids that segregate for resistance to rhizomania.

Root rot appeared to be caused by Erwinia.

RJAP = raw juice apparent purity.

Test area was under high nitrogen status and was watered twice per week with sprinkler irrigation. Despite rhizomania and cyst nematode, top growth was very good and a differential green vs yellowing due to rhizomania did not occur. Stands were good except for a few entries. For entries with low stands, as necessary, adjustments for yield were made based upon missing feet of row.

Replications 5-8 were grown under moderate rhizomania conditions adjacent to replications 1-4. The inoculation histories of 4695-1 and 4695-2 were different. Test 4695-1 was inoculated in 1993. Infested soil was spread over the area and sugarbeets were grown from September to November, then disced under. In 1994, sugarbeet was grown from May to August and then disced under. For Test 4695-2, infested soil was broadcast over the area in 1994 and sugarbeets grown from August to November, then disced under. Starting in November 1994, these adjacent areas were farmed as a single unit receiving the same cultural practices and inputs.

Test 4695-2 (replications 5-8) was not scored for rhizomania and was mechanically harvested. One sugar sample was harvested from each plot. A correlation of $r = 0.78^{**}$ was calculated between Tests 4695-1 vs 4695-2 for gross sugar yield. For %R from 4695-1 vs sugar yield for 4695-2, $r = 0.58^{**}$. For DI from 4695-1 vs sugar yield for 4695-2, $r = -0.66^{**}$. Based upon these values, the means for the 96 entries x 8 replications ANOVA would probably offer the most accurate information.

TEST 4695-3. NON-CBGA ENTRIES IN CODED RHIZOMANIA TESTS, SALINAS, CA., 1995

18 entries x 8 replications, RCB (entries imbedded in Test 4695)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 23 & 30, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100' No.	RJAP %	RZM Resistance	
		Sugar Lbs	Beets Tons				DI	%R
BTS-1	Betaseed 3-29-95	8503	32.03	13.25	156	78.8	4.2	43.9
BTS-2	Betaseed 3-29-95	8091	30.47	13.30	154	78.7	4.3	39.5
BTS-3	Betaseed 3-29-95	8686	32.67	13.29	162	77.1	4.3	39.8
BTS-4	Betaseed 3-29-95	7649	29.68	12.87	154	79.2	4.4	40.3
BTS-5	Betaseed 3-29-95	7712	27.75	14.11	143	78.8	3.8	57.7
US H11	11-16-94	4369	20.28	10.61	166	79.0	4.8	23.8
Rizor	RZ3/1022 (1-21-93)	8791	29.27	15.00	163	78.1	4.0	51.6
6770	KWS high %S check	4979	18.98	13.30	151	80.2	4.9	17.0
4454	Comm. check	5842	23.47	12.41	162	76.9	4.7	25.4
US H11	11-16-94	4785	20.74	11.53	172	80.4	4.8	26.9
R480-45H50	F92-790-15CMS x R380-45	8897	32.91	13.46	168	77.4	3.8	63.0
4911-4H50	F92-790-15CMS x 3911-4	8143	30.04	13.38	166	79.3	3.9	56.0
4915H50	F92-790-15CMS x RZM 3915	7974	30.78	12.89	159	78.4	4.1	48.9
4918H50	F92-790-15CMS x RZM 3918	7929	31.27	12.62	154	78.6	4.2	43.6
R422R4H50	F92-790-15CMS x RZM R422R4, %	8073	31.69	12.73	168	77.0	3.9	55.3
R422Y3H15	3915aa x R322Y3, %	8113	30.16	13.39	161	78.5	3.8	60.7
R440H50	F92-790-15CMS x RZM R40(C)	6885	25.72	12.97	167	78.5	4.3	42.9
R479H50(Iso)	F92-790-15CMS x RZM R379	7158	27.88	12.81	169	78.2	4.1	48.6
Mean		7354.3	28.10	13.00	160.8	78.5	4.2	43.6
LSD (.05)		991.3	3.68	0.72	14.4	2.3	0.5	24.2
C.V. (%)		13.6	13.20	5.56	9.1	2.9	8.8	39.1
F value		16.3**	11.37**	13.15**	2.1*	1.5NS	3.7**	2.5**

NOTES: For the USDA entries, R380-45 ≈ C80-45, 3911-4 ≈ C911-4, 3918 ≈ C918, R422R4 is the 4th cycle synthetic for resistance to rhizomania from C50 (50% *Beta maritima*), R322Y3 is the 3rd cycle synthetic for resistance to virus yellows from C50, RZM R40(C) is a composite of different sources of resistance, and R379 ≈ C79-1 ≈ C37Rz.

TEST 4695-3-1. NON-CBGA ENTRIES IN CODED RHIZOMANIA TEST (SEVERE RHIZOMANIA), SALINAS, CA., 1995

18 entries x 4 replications, RCB (entries imbedded in Test 4695)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 23, 1995

Variety	Description	Acre Yield		Beets/ 100'	Sucrose %	RJAP %	RZM Resistance	
		Sugar Lbs	Beets Tons				DI	%R
BTS-1	Betaseed 3-29-95	7581	29.40	146	12.93	79.1	4.2	43.9
BTS-2	Betaseed 3-29-95	6851	26.19	150	13.18	77.7	4.3	39.5
BTS-3	Betaseed 3-29-95	7934	30.28	165	13.10	77.0	4.3	39.8
BTS-4	Betaseed 3-29-95	6456	26.56	155	12.26	79.1	4.4	40.3
BTS-5	Betaseed 3-29-95	6230	23.05	139	14.05	77.8	3.8	57.7
US H11	11-16-94	3720	18.51	173	9.88	78.1	4.8	23.8
Rizor	RZ3/1022 (1-21-93)	8002	27.36	154	14.65	77.4	4.0	51.6
6770	KWS high %S check	3789	14.23	164	13.58	80.1	4.9	17.0
4454	Comm. check	4762	19.54	164	12.21	75.6	4.7	25.4
US H11	11-16-94	3751	16.92	166	11.20	80.2	4.8	26.9
R480-45H50	F92-790-15CMS x R380-45	8057	31.27	161	12.85	75.6	3.8	63.0
4911-4H50	F92-790-15CMS x 3911-4	5944	22.81	169	12.88	78.9	3.9	56.0
4915H50	F92-790-15CMS x RZM 3915	6767	27.54	144	12.28	78.0	4.1	48.9
4918H50	F92-790-15CMS x RZM 3918	6339	25.67	150	12.34	77.8	4.2	43.6
R422R4H50	F92-790-15CMS x RZM R422R4, %	7394	29.99	155	12.36	76.5	3.9	55.3
R422Y3H15	3915aa x R322Y3, %	7048	27.24	148	12.91	77.3	3.8	60.7
R440H50	F92-790-15CMS x RZM R40(C)	5403	21.24	171	12.74	78.0	4.3	42.9
R479H50(Iso)	F92-790-15CMS x RZM R379	6135	24.79	174	12.41	77.6	4.1	48.6
Mean		6231.3	24.59	158.1	12.66	77.9	4.2	43.6
LSD (.04)		1487.0	5.63	20.0	1.29	3.8	0.5	24.2
C.V. (%)		16.8	16.12	8.9	7.19	3.5	8.8	39.1
F value		7.6**	6.08**	2.3*	5.13**	0.9NS	3.7**	2.5**

TEST 4695-3-2. NON-CBGA ENTRIES IN CODED RHIZOMANIA TEST (MODERATE RHIZOMANIA), SALINAS, CA., 1995

18 entries x 4 replications, RCB (embedded in Test 4695)
1-row plots, 20 ft. long

Planted: May 3, 1995
Harvested: October 30, 1995

Variety	Description	Acre Yield		Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
		Sugar Lbs	Beets Tons				
BTS-1	Betaseed 3-29-95	9425	34.65	13.58	165	0.7	78.4
BTS-2	Betaseed 3-29-95	9331	34.76	13.43	158	0.0	79.7
BTS-3	Betaseed 3-29-95	9437	35.07	13.48	159	0.0	77.2
BTS-4	Betaseed 3-29-95	8841	32.79	13.48	154	0.0	79.3
BTS-5	Betaseed 3-29-95	9193	32.45	14.18	148	0.0	79.8
US H11	11-16-94	5017	22.05	11.35	160	0.0	79.8
Rizor	RZ3/1022 (1-21-93)	9579	31.19	15.35	171	0.0	78.9
6770	KWS high %S check	6169	23.73	13.03	139	0.0	80.3
4454	Comm. check	6922	27.41	12.60	160	0.0	78.3
US H11	11-16-94	5819	24.57	11.85	178	0.0	80.7
R480-45H50	F92-790-15CMS x R380-45	9736	34.55	14.08	174	0.0	79.3
4911-4H50	F92-790-15CMS x 3911-4	10342	37.28	13.88	163	0.0	79.7
4915H50	F92-790-15CMS x RZM 3915	9182	34.02	13.50	175	0.0	78.7
4918H50	F92-790-15CMS x RZM 3918	9518	36.87	12.90	158	0.0	79.3
R422R4H50	F92-790-15CMS x RZM R422R4,%	8753	33.39	13.10	180	0.0	77.5
R422Y3H15	3915aa x R322Y3, %	9179	33.08	13.88	175	0.0	79.8
R440H50	F92-790-15CMS x RZM R40(C)	7966	30.21	13.20	163	0.0	79.1
R479H50(Iso)	F92-790-15CMS x RZM R379	8182	30.98	13.20	165	0.0	78.9
Mean		8477.3	31.61	13.34	163.4	0.0	79.2
LSD (.05)		1276.9	4.41	0.69	16.9	0.5	2.9
C.V. (%)		10.6	9.82	3.63	7.3	848.5	2.6
F value		11.3**	8.21**	13.16**	3.3**	1.0NS	0.8NS

TEST B195. HYBRID PERFORMANCE OF MULTIGERM, SELF-FERTILE POPULATIONS & PROGENIES,
BRAWLEY, CA., 1994-95

16 entries x 8 replications, RCB (equalized)
1-row plots, 27 ft. long

Planted: September 26, 1994
Harvested: May 17, 1995

Variety	Description	Acre Yield		Sucrose		Bolters		Beets/100'		Clean Beets %	NO3-N Score
		Sugar Lbs	Beets Tons	%	%	%	%	No.	No.		
US H11	rec'd 1/10/94	7588	24.04	15.8	0.0	158	92.9				66
HH 41	L412310, 8/30/94	9425	29.10	16.2	0.0	147	93.5				67
R378H52	F92-790-15H39 x R278,Y	10688	33.67	15.9	0.0	145	95.1				66
R480-45H52	F92-790-15H39 x R280-45	10051	31.14	16.1	0.0	134	94.5				80
4911H52	F92-790-15H39 x RZM 3911	10033	31.27	16.0	0.7	143	95.1				55
4915H52	F92-790-15H39 x RZM 3911,3915	9714	31.03	15.7	0.3	141	93.7				89
4916H52	F92-790-15H39 x RZM 3916	9988	32.33	15.4	0.0	154	93.3				91
4917H52	F92-790-15H39 x RZM 3917	10588	33.45	15.8	0.0	138	94.1				114
4918H52	F92-790-15H39 x RZM 3918	10119	32.17	15.8	0.0	143	94.0				78
4911-4H52	F92-790-15H39 x 3911-4m	9438	29.94	15.7	0.0	142	94.0				65
4913-6H52	F92-790-15H39 x 3913-6	9672	31.17	15.5	0.0	143	93.9				95
4913-9H52	F92-790-15H39 x 3913-9	10063	32.37	15.5	0.0	141	94.3				94
4915-6H52	F92-790-15H39 x 3915-6	9783	30.36	16.1	0.0	133	93.9				72
4915-7H52	F92-790-15H39 x 3915-7	8840	28.22	15.7	0.0	136	93.9				88
4915-22H52	F92-790-15H39 x 3915-22	9512	30.22	15.8	0.0	136	94.2				115
4915-34H52	F92-790-15H39 x 3915-34	9724	31.02	15.7	0.0	142	93.7				77
Mean		9701.6	30.72	15.8	0.1	142.3	94.0				82.0
LSD (.05)		1107.5	3.02	0.8	0.4	11.3	1.6				51.7
C.V. (%)		11.5	9.92	4.8	616.9	8.0	1.7				63.7
F value		3.3**	4.54**	0.8NS	1.8NS	2.8**	1.0NS				0.9NS

TEST B395. HYBRID PERFORMANCE OF MULTIGERM LINES & PROGENIES, BRAWLEY, CA., 1994-95

32 entries x 8 replications, RCB (equalized)
1-row plots, 27 ft. long

Planted: September 26, 1994
Harvested: May 19, 1995

Variety	Description	Acre Yield		Sucrose	Bolters	Beets/100'		Clean	NO3-N
		Sugar Lbs.	Beets Tons			%	No.	%	
US H11	1/10/94	7435	26.52	14.0	0.0	0.0	128	91.1	183
HH41	L412310, 8/30/94	10750	35.94	15.0	0.0	0.0	137	93.1	141
R470H50	F92-790-15CMS x RZM R370	10836	36.88	14.7	0.0	0.0	133	94.7	203
R476H50	F92-790-15CMS x RZM 376,Y	11094	39.59	14.0	0.3	0.3	142	94.0	256
R476-43-#H50	F92-790-15CMS x RZM R376-43-#	10693	37.19	14.4	1.1	1.1	134	93.8	223
R476-43-14H50	F92-790-15CMS x RZM R376-43-14	11564	39.04	14.8	0.0	0.0	146	94.2	167
R476-43-15H50	F92-790-15CMS x RZM R376-43-15	11179	38.64	14.5	0.0	0.0	136	94.2	202
R476-89-#H50	F92-790-15CMS x RZM R376-89-#	10877	38.29	14.2	0.0	0.0	136	94.5	217
R476-89-5H50	F92-790-15CMS x RZM R376-89-5	10032	31.59	15.9	0.0	0.0	141	93.1	105
R476-89-18H50	F92-790-15CMS x RZM R376-89-18	11568	39.55	14.7	0.0	0.0	142	94.5	167
R478H50	F92-790-15CMS x RZM R378,Y	10370	35.68	14.5	0.9	0.9	137	93.8	186
R479H50 (Iso)	F92-790-15CMS x RZM R379	9188	33.66	13.6	1.0	1.0	138	93.5	213
R480H50	F92-790-15CMS x RZM R380,Y	10152	35.56	14.3	0.6	0.6	142	93.7	199
R480-45H50	F92-790-15CMS x RZM 280-45	9734	31.92	15.3	0.0	0.0	129	92.0	156
R481-43H50	F92-790-15CMS x RZM R381-43	11463	36.83	15.6	1.2	1.2	142	95.3	162
R481-89H50	F92-790-15CMS x RZM R381-89	10555	37.86	13.9	3.0	3.0	140	94.6	253
R483H50	F92-790-15CMS x RZM R383	10667	34.95	15.2	1.8	1.8	133	93.6	203
R484H50	F92-790-15CMS x RZM R384	10795	34.71	15.5	0.3	0.3	143	93.8	120
R422R4H50	F92-790-15CMS x RZM R322R4,%	9572	33.46	14.3	12.2	12.2	142	91.2	199
R422Y3H50	F92-790-15CMS x R322Y3,%	9527	30.90	15.4	0.6	0.6	138	92.9	99
R436R2H50	F92-790-15CMS x RZM R336 (R22)	10102	34.96	14.4	1.0	1.0	142	91.6	174
R437R2H50	F92-790-15CMS x RZM R337 (WB151)	9896	33.90	14.6	1.2	1.2	148	92.4	153
R440H50	F92-790-15CMS x RZM R40(C)	9426	31.11	15.1	0.0	0.0	132	92.1	151
4911-4H50	F92-790-15CMS x 3911-4m	10888	34.46	15.8	0.7	0.7	137	94.0	88
4915H50	F92-790-15CMS x RZM 3915,3911	9894	33.61	14.7	0.6	0.6	142	92.4	162
4918H50	F92-790-15CMS x RZM 3918	10594	34.58	15.3	0.7	0.7	139	90.8	141
4913-70 (H50) *	F92-790-15CMS x RZM 3913-70	6291	20.59	15.3	0.0	0.0	135	91.7	70
4913-71 (H50) *	F92-790-15CMS x RZM 3913-71	8733	29.79	14.6	0.0	0.0	123	93.8	126

TEST B395. HYBRID PERFORMANCE OF MULTIGERM LINES & PROGENIES, BRAWLEY, CA., 1994-95

(cont.)

Variety	Description	Acre Yield		Sucrose	Bolters	Beets/ 100'	Clean Beets	NO3-N
		Sugar Lbs	Beets Tons	%	%	No.	%	Score
3913-18H50	F92-790-15CMS x 2913-18	10006	31.76	15.8	0.0	135	92.5	116
3913-22H50	F92-790-15CMS x 2913-22	10506	34.36	15.3	0.0	130	89.2	119
3913-25H50	F92-790-15CMS x 2913-25	9728	31.91	15.3	0.4	124	92.4	119
3913-5H50	F92-790-15CMS x 2913-5	10325	34.94	14.8	0.3	137	92.9	132
Mean		10138.7	34.21	14.8	0.9	136.9	93.0	162.6
LSD (.05)		976.5	2.87	0.8	2.0	12.9	2.4	64.7
C.V. (%)		9.8	8.52	5.2	227.1	9.5	2.6	40.4
F value		10.0**	14.35**	4.7**	9.6**	1.6*	2.6**	4.0**

*On original seed list for packaging, I listed these two entries as 4913-70 and 4913-71, therefore, I do not know if the line or hybrid seed was packaged. Will be able to tell from appearance of plots. RTL

TEST B495. PERFORMANCE OF EXPERIMENTAL HYBRIDS, BRAWLEY, CA., 1994-95

32 entries x 8 replications, RCB (equalized)
1-row plots, 27 ft. long

Planted: September 26, 1994
Harvested: May 22, 1995

Variety	Description	Acre Yield		Sucrose	Bolters	Beets/100'		NO3-N
		Sugar Lbs	Beets Tons			%	No.	
HH 41	L412310, 8/30/94	8944	32.58	13.7	0.0	0.0	140	145
US H11	1/10/94	7056	27.98	12.6	0.0	0.0	143	179
SS IV3	L94617 9/7/94	10168	35.97	14.1	0.9	0.9	143	134
2J0179	Betaseed 9/9/94	8905	29.57	15.1	0.0	0.0	130	94
Rhizoguard	L892301, 8/30/94	7929	29.21	13.6	0.4	0.4	140	148
MH3013	SM2010, 9-9-94	10216	34.74	14.7	0.0	0.0	145	150
R378H52	F92-790-15H39 x R278,Y	9910	36.67	13.5	0.3	0.3	145	172
R380H52	F92-790-15H39 x R280,Y	9587	37.04	12.9	0.0	0.0	142	209
R384H52	F92-790-15H39 x R176-43, -89-#	8562	34.75	12.3	0.0	0.0	141	234
R480-45H8	F82-546H3 x R280-45	8043	30.58	13.2	0.0	0.0	139	196
R480-45H20	87-309H3 x R280-45	8794	30.92	14.2	0.0	0.0	146	144
R480-45H37	U84-306CMS x R280-45	10040	37.30	13.5	0.0	0.0	138	168
R480-45H39	91-762-17CMS x R280-45	8565	32.05	13.4	0.4	0.4	123	171
R480-45H46	F92-790-6CMS x R280-45	9285	32.86	14.1	0.0	0.0	145	139
R480-45H50	F92-790-15CMS x R280-45	9768	34.54	14.1	0.0	0.0	139	165
R480-45H51	F92-790-15H26 x R280-45	8730	30.81	14.2	0.0	0.0	135	138
R480-45H52	F92-790-15H39 x R280-45	9327	34.68	13.5	0.0	0.0	131	159
R480-45H54	F92-790-54CMS x R280-45	9544	34.38	13.9	0.0	0.0	134	134
4918H37	84-306CMS x RZM 3918	9102	34.44	13.2	0.4	0.4	133	162
4918H50	F92-790-15CMS x RZM 3918	9551	33.65	14.2	0.4	0.4	131	136
4918H52	F92-790-15H39 x RZM 3918	9167	35.07	13.1	1.1	1.1	130	158
4915H52	F92-790-15H39 x RZM 3915	8999	34.35	13.2	0.0	0.0	138	175
4915H93	RZM 3890aa x RZM 3915	8913	33.71	13.3	0.7	0.7	125	161
4915H94	RZM 3894aa x RZM 3915	8420	31.48	13.4	0.4	0.4	126	175
R440H52	F92-790-15H39 x RZM R40(C)	8912	34.77	12.8	0.0	0.0	135	207
R479H50 (Sp)	F92-790-15CMS x R379	8976	34.24	13.1	3.0	3.0	140	213
R479H52	F92-790-15H39 x R379	9441	39.45	12.0	1.7	1.7	143	243
R422R4H52	F92-790-15H39 x RZM R322R4,*	8651	36.36	11.9	7.9	7.9	139	246

TEST B495. PERFORMANCE OF EXPERIMENTAL HYBRIDS, BRAWLEY, CA., 1994-95

(cont.)

Variety	Description	Acre Yield		Sucrose	Bolters	Beets/ 100'	Clean Beets	NO3-N
		Sugar Lbs	Beets Tons	%	%	No.	%	Score
R422Y3H52	F92-790-15H39 x R322Y3,%	9249	33.40	13.8	2.6	132	92.3	133
R434R2H50	F90-790-15CMS x RZM R334(R05)	8111	29.22	13.9	1.1	144	92.5	160
R378H39	91-762-17CMS x R278,Y	10350	38.58	13.4	0.0	142	95.0	180
6770	KW30161 365MN, 2/16/94	8367	27.90	15.0	2.3	139	93.8	103
Mean		9049.4	33.54	13.5	0.7	137.3	94.0	166.5
LSD (.05)		906.5	3.21	0.8	1.5	12.1	1.4	45.5
C.V. (%)		10.2	9.70	5.6	207.7	8.9	1.5	27.8
F value		5.0**	6.55**	8.1**	8.1**	2.1**	3.4**	4.9**

TEST B295. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA., 1994-95

32 entries x 8 replications, RCB (equalized)
1-row plots, 27 ft. long

Planted: September 28, 1994
Harvested: May 18, 1995

Code	Variety	Source	Acre Yield		Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
			Sugar Lbs	Beets Tons					
16	HM 3044	Hill M-H	11370	34.68	16.4	138	0.0	94.0	59.9
21	SS-IV1	Spreckels	11242	36.31	15.5	139	0.0	95.2	92.4
9	HH 41	Holly	10916	35.65	15.3	144	0.0	94.2	124.3
22	94HX26	Holly	10803	34.24	15.8	145	0.0	94.1	101.6
18	3BG6382	Betaseed	10716	33.16	16.2	156	0.4	93.0	78.8
24	HH 51	Holly	10565	34.13	15.5	142	0.3	94.7	105.9
25	HM 3045	Hill M-H	10561	32.43	16.3	126	0.0	92.7	65.3
2	HM 3013	Hill M-H	10529	33.24	15.8	148	0.0	93.7	132.2
28	SS-IV3	Spreckels	10526	33.59	15.7	143	0.3	93.8	94.2
7	HM 3005	Hill M-H	10504	32.62	16.1	143	0.0	93.7	91.0
19	SS-IV2	Spreckels	10487	34.51	15.2	144	0.0	93.4	89.9
6	94HX28	Holly	10425	34.13	15.3	143	0.0	94.1	124.4
5	H93778	Spreckels	10386	35.25	14.7	136	0.0	95.3	132.6
8	93HX30	Holly	10295	33.31	15.5	131	0.0	94.2	125.4
1	Beta 4684	Betaseed	10256	32.71	15.7	142	0.0	94.9	103.3
12	94HX29	Holly	10126	32.29	15.7	138	0.0	93.8	93.6
30	4CG6590	Betaseed	10105	33.24	15.2	132	0.0	93.4	118.5
27	3BG6406	Betaseed	10035	31.99	15.7	160	0.0	91.4	111.2
3	94HX27	Holly	9771	30.84	15.9	140	0.0	93.4	104.8
15	Beta 4823	Betaseed	9729	31.32	15.5	149	0.0	92.5	106.3
31	HM 3012	Hill M-H	9669	30.27	16.0	139	0.0	94.9	58.1
17	HH 79	Holly	9609	32.90	14.6	133	0.4	93.6	134.7
11	HH 77	Holly	9607	31.22	15.4	148	0.0	93.3	96.0
14	SS-NB6	Spreckels	9524	31.46	15.2	142	0.0	95.1	144.9
23	4CG6591	Betaseed	9392	30.09	15.6	142	0.0	91.5	93.4
32	4915H93	USDA	9382	31.38	15.0	131	0.4	94.4	131.9
20	93HX32	Holly	9340	30.39	15.4	144	0.0	92.4	75.8
4	2BG6079	Betaseed	9339	29.33	15.9	142	0.3	92.2	80.3

TEST B295. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA., 1994-95

(cont.)

Code	Variety	Source	Acre Yield		Beets/ 100'	Bolters	Clean Beets	NO3-N
			Sugar Lbs	Beets Tons				
26	HM 3046	Hill M-H	9323	27.89	142	0.0	93.5	72.9
13	4CG6592	Betaseed	9043	29.17	129	0.4	92.4	102.9
29	H93814	Spreckels	8975	30.42	141	0.3	92.5	142.8
10	US H11	Standard	8078	27.66	132	0.0	92.2	185.3
Mean			10019.7	32.25	140.8	0.1	93.5	105.5
LSD (.05)			761.8	2.41	14.1	0.5	1.2	47.3
C.V. (%)			7.7	7.60	10.2	560.4	1.3	45.5
F value			7.0**	6.21**	2.1**	0.8NS	6.5**	2.7NS

TEST B295. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA., 1994-95

(cont.)

Code	Variety	Recover.	Recover.	Recover.	Known SugarLoss	Sodium	Potassium	NH ₄ -N	Impur.
		Sugar lbs/a	Sugar lbs/t	Sugar %					
16	HM 3044	10220	295	89.8	1150	326	2138	480	11040
21	SS-IV1	10009	276	89.0	1234	443	2304	420	11301
9	HH 41	9671	271	88.5	1245	412	2345	458	11651
22	94HX26	9705	284	89.8	1098	412	2174	395	10625
18	3BG6382	9688	294	90.4	1028	326	2223	374	10253
24	HH 51	9398	275	88.9	1167	379	2418	423	11392
25	HM 3045	9583	296	90.7	978	421	1896	402	10029
2	HM 3013	9455	283	89.5	1074	401	2251	401	10835
28	SS-IV3	9401	281	89.2	1125	420	2252	419	11079
7	HM 3005	9392	288	89.4	1112	392	2322	436	11320
19	SS-IV2	9244	268	88.1	1243	456	2324	482	11984
6	94HX28	9252	272	88.7	1173	459	2270	432	11387
5	H93778	9068	258	87.2	1318	493	2682	421	12429
8	93HX30	9209	276	89.3	1086	419	2249	400	10888
1	Beta 4684	9086	279	88.6	1170	407	2282	494	11828
12	94HX29	9093	282	89.7	1033	377	2198	405	10664
30	4CG6590	8985	271	88.8	1120	408	2486	377	11225
27	3BG6406	8923	278	88.7	1113	368	2278	496	11691
3	94HX27	8730	283	89.2	1041	422	2102	474	11233
15	Beta 4823	8646	276	88.8	1083	371	2323	463	11499
31	HM 3012	8678	287	89.7	991	314	2170	459	10882
17	HH 79	8363	254	86.8	1246	351	2678	497	12640
11	HH 77	8451	271	87.9	1155	265	2418	563	12319
14	SS-NB6	8295	264	87.0	1230	439	2427	569	13004
23	4CG6591	8349	277	88.7	1043	302	2460	460	11578
32	4915H93	8211	262	87.5	1171	384	2566	485	12368
20	93HX32	8229	271	88.0	1111	286	2500	518	12168
4	2BG6079	8411	286	89.9	928	374	2280	381	10633

(cont.)

Code	Variety	Recover.		Recover.		Recover.		Known		Sodium		Potassium		NH ₄ -N		Impur.	
		Sugar	lbs/a	Sugar	lbs/t	%		Sugar	lbs/a	ppm		ppm		ppm		Value	
26	HM 3046	8394		302		90.0		929		350		2005		502		11000	
13	4CG6592	8015		274		88.5		1028		341		2457		467		11774	
29	H93814	7873		260		87.6		1103		466		2486		437		11997	
10	US H11	7043		254		86.9		1035		366		2466		537		12543	
Mean		8908.4		276.6		88.8		1111.2		385.8		2325.9		453.9		11476.8	
LSD (.05)		728.7		14.3		1.6		155.1		94.4		192.3		71.1		1230.7	
C.V. (%)		8.3		5.3		1.8		14.2		24.8		9.4		15.9		10.9	
F value		7.0**		5.3**		3.3*		2.9*		2.6*		6.4**		4.2**		2.7NS	

TEST B795. LATE HARVEST, HIGH TEMPERATURE ROOT ROT EVALUATION AND PERFORMANCE
UNDER SEVERE RHIZOMANIA CONDITIONS, BRAWLEY, CA., 1994-95

24 entries x 8 replications, RCB (equalized)
1-row plots, 18 ft. long

Planted: October 5, 1994
Harvested: May 24, 1995

Variety	Description	Acre Yield		Beets/ 100'	Clean Beets	NO3-N Score
		Sugar Lbs	Beets Tons			
Rhizoguard	L892301, 8/30/94	3409	11.42	122	95.4	96
SS-IV3	L94617, 9/7/94	4000	14.11	124	93.1	140
2J0179	Betaseed, 9/9/94	5300	16.08	105	95.4	54
Rizor	RZ3/1022, 1993	5732	18.04	129	95.8	206
US H11	1/10/94	3597	13.54	115	91.1	142
HH41	L412310, 8/30/94	4998	18.37	113	93.4	123
4915H93	RZM 3890aa x RZM 3915	4269	14.71	112	94.5	175
R422R4H52	F92-790-15H39 x RZM R322R4,%	7354	26.00	118	92.0	211
R470	RZM R370	5580	19.04	119	96.0	149
R478	RZM R378, Y	5761	19.20	113	95.6	135
R480	RZM R380, Y	5151	17.04	120	95.7	97
R484	RZM R384	5881	19.70	120	95.1	119
N457	NR-RZM N357,8 (BC ₃ F ₂)	4196	14.83	114	93.1	123
4918(Sp)	RZM 3918aa x A	3606	11.55	107	92.6	66
4918H52	F92-790-15H39 x RZM 3918	4297	14.98	119	95.4	143
R440H18	3918aa x RZM R40(C)	3720	12.86	118	92.5	138
R440H52	F92-790-15H39 x RZM R40(C)	4740	16.63	119	92.8	125
R422R4H15	3915aa x RZM R322R4,%	7286	26.29	122	91.9	206
R422R4(Sp)	RZM R322R4, %	5430	20.58	122	89.9	239
R436R2	RZM R336, (R22)	5501	19.53	124	90.6	154
R437R2	RZM R337, (WB151)	4442	15.46	120	90.9	141
R432R2	RZM R322, (R04)	3219	11.67	114	91.5	155
R443	RZM 3284,5, (R81 x (C37xR22))	6227	20.75	123	93.3	120
R444	RZM 3287, (915aa x (C37 x R22))	6014	21.47	117	92.5	144
Mean		4988.0	17.24	117.9	93.3	141.7
LSD (.05)		1277.3	4.35	13.0	1.6	62.9
C.V. (%)		26.0	25.63	11.2	1.8	45.1
F value		6.3**	6.81**	1.4NS	10.6**	3.7*

Note: Test B795 set astraddle of a field plot area with two histories of rhizomania. The north half or more of the test was in an area of severe rhizomania and followed rhizomania tests grown in 1993-94. The south part of the test had less severe rhizomania. Even though the test was equalized (every variety in every field row and replication), it was highly variable. Entries ranged from zero yield in some plots to nearly normal yield in other plots. Visually and in terms of sugar yield, the best (most rhizomania resistant?) entries were those derived from C50 (R22) germplasm. For example, R422R4H52 and R422R4H15 are hybrids with C4 synthetic from C50. R436R2, R443, and R444 are breeding lines with a component from C50 (R22).

TEST B995. EVALUATION OF LINES & HYBRIDS UNDER RHIZOMANIA CONDITIONS, BRAWLEY, CA., 1994-95

48 entries x 8 replications, RCB (equalized); 3 sub-tests (16 x 8)
1-row plots, 18 ft. long

Planted: October 3, 1994
Harvested: May 23, 1995

Variety	Description	Acre Yield		Beets/ 100'	Clean Beets %	NO3-N Score
		Sugar Lbs	Beets Tons			
Set 1: B995-1 (16 varieties x 8 reps, RCB (equalized))						
EVALUATION OF HYBRIDS WITH DIFFERENT SOURCES OF RESISTANCE						
US H11	1/10/94	6752	24.05	0.0	129	92.3
HH41	L412310, 8/30/94	8784	31.07	0.0	128	94.8
RRhizoguard	L892301, 8/30/94	7841	27.62	0.0	130	96.5
SS-IV3	L94617, 9/7/94	8976	32.51	0.0	135	94.9
2J0179	Betaseed, 9/9/94	9424	28.85	0.0	130	94.5
Rizor	RZ3/1022, 1993	10163	31.82	0.6	134	96.0
4918H37	84-306CMS x RZM 3918	8451	30.78	0.0	125	93.9
4915H93	RZM 3890aa x RZM 3915	8434	29.72	0.6	121	94.7
R422R4H50	92-790-15CMS x RZM R322R4, %	9067	30.94	6.6	138	92.7
R428R2H50	92-790-15CMS x RZM R328	8367	28.44	0.0	133	91.8
R432R2H50	92-790-15CMS x RZM R332	8461	31.58	2.8	128	92.2
R434R2H50	92-790-15CMS x RZM R334	8640	29.08	0.0	126	92.9
R436R2H50	92-790-15CMS x RZM R336	9156	32.67	0.0	137	93.3
R437R2H50	92-790-15CMS x RZM R337	8854	31.12	2.1	131	93.9
RR479H50	92-790-15CMS x RZM R379	9463	32.82	0.5	138	94.5
R440H50	92-790-15CMS x RZM R40(C)	8077	27.02	0.0	128	93.5
Mean		8681.9	30.01	0.8	130.7	93.9
LSD (.05)		883.6	2.72	0.8	10.7	1.3
C.V. (%)		10.3	9.15	5.8	157.8	1.4
F value		6.0**	6.06**	6.8**	14.4**	7.9**
					1.6NS	2

TEST B995. EVALUATION OF LINES & HYBRIDS UNDER RHIZOMANIA CONDITIONS, BRAWLEY, CA, 1994-95

48 entries x 8 replications, RCB (equalized). ANOVA to compare means across sets of entries.

Mean	8248.5	28.86	14.3	1.4	128.6	93.8	177.8
LSD (.05)	926.1	2.90	0.8	2.3	10.7	1.4	95.2
C.V. (%)	11.4	10.18	5.9	164.4	8.5	1.5	54.4
F value	8.6**	9.81**	5.7**	14.0**	1.7NS	9.6**	2.2**

TEST B995. EVALUATION OF LINES & HYBRIDS UNDER RHIZOMANIA CONDITIONS, BRAWLEY, CA., 1994-95

(cont.)

Variety	Description	Acre Yield		Beets Tons	Sucrose %	Bolters %	Beets/		Clean
		Sugar Lbs.	Beets 100'				No.	%	
Set 2: B995-2 (16 varieties x 8 reps, RCB (equalized))									
SOURCES OF RESISTANCE IN C37 BACKGROUND									
U86-37	Inc. C37	5872	19.76		14.9	0.0	124	90.9	70
R479 (Iso)	C79-1, Rz, RZM R379	7910	29.72		13.4	1.1	122	96.0	201
R424	C79-2, WB41, RZM 3250	7469	25.16		14.9	0.0	126	91.5	135
R425	C79-3, WB42, RZM 3251	6527	23.01		14.2	0.0	130	91.7	127
R428	C79-4, PI07, RZM 3202	6683	23.12		14.3	0.6	128	92.9	176
R432	C79-5, R04, RZM 3201	6586	24.59		13.4	0.5	127	91.3	231
R434	C79-6, R05, RZM 3245	7766	26.10		14.9	0.0	125	93.7	145
R435	C79-7, SES, RZM 3242	8168	26.62		15.3	0.0	122	93.2	154
R436	C79-8, R22, RZM 3243	8034	29.11		13.8	0.0	130	92.8	224
R437	C79-9, WB151, RZM 3247	7757	27.15		14.4	0.0	130	91.9	155
R441	C79-10, WB169, RZM 3248	7901	30.13		13.1	0.0	126	93.2	211
R442	C79-11, WB258, RZM 3249	7980	28.87		13.8	0.5	134	94.1	183
R428R2	PI07, RZM R328	6748	22.32		15.1	0.0	124	91.9	83
R432R2	R04, RZM R332	6452	24.70		13.0	8.1	136	92.4	264
R436R2	R22, RZM R336	8105	29.68		13.7	2.7	123	92.9	189
R437R2	WB141, RZM R337	7720	27.02		14.2	2.9	127	93.1	149
Mean		7354.8	26.07		14.1	1.0	127.2	92.7	168.5
LSD (.05)		960.1	2.96		0.8	1.9	10.7	1.5	70.9
C. V. (%)		13.2	11.49		5.5	190.9	8.5	1.6	42.5
F value		4.7**	8.27**		7.0**	9.3**	1.1NS	5.4**	4.3

TEST B995. EVALUATION OF LINES & HYBRIDS UNDER RHIZOMANIA CONDITIONS, BRAWLEY, CA., 1994-95

(cont.)

Variety	Description	Acre Yield		Beets/ 100'	Clean Beets %	NO3-N Score
		Sugar Lbs	Beets Tons			
Set 3: B995-3 (16 varieties x 8 reps, RCB (equalized))						
EVALUATION OF BREEDING LINES WITH RHIZOMANIA RESISTANCE						
HM3013	SM2010, 9/9/94	8550	31.18	13.7	0.0	134
R470	RZM R370	9241	33.74	13.6	0.0	116
R476	RZM R376, Y	8652	32.73	13.2	0.6	126
R478	RZM R378, Y	9346	30.31	15.4	0.0	120
R480	RZM R380, Y	9215	31.29	14.8	0.0	133
R483	RZM R383(R)	8915	30.75	14.5	0.5	126
R484	RZM R384	9008	30.11	14.9	0.5	126
4918 (sp)	RZM 3918aa x A	7796	25.89	15.1	0.0	127
R443	RZM 3284,5 (R81 x R22)	9715	33.40	14.6	5.1	130
R422R5 (Iso)	RZM R322R4 (GSY)	7358	26.90	13.8	17.7	123
R422Y3 (Sp)	Inc. R322Y3, %	9290	31.90	14.6	3.7	132
R422R4H15	3915aa x RZM R322R4, %	8585	30.92	13.9	7.2	135
R422Y3H15	3915aa x R322Y3, %	9025	30.88	14.6	3.1	136
R440H18	3918aa x RZM R40(C)	8909	31.30	14.3	0.0	131
Z430	RZM Z330	8740	31.02	14.1	0.0	126
N457	NR-RZM N357,8 (BC ₃ F ₂)	6997	25.95	13.5	1.0	127
Mean		8708.8	30.52	14.3	2.5	128.0
LSD (.05)		932.5	3.12	0.8	3.2	11.1
C.V. (%)		10.8	10.31	5.3	130.3	8.8
F value		4.9**	4.49**	5.5**	16.5**	1.9NS
						7.9**
						16.5**

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS
UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95

48 entries x 8 replications, RCB (equalized)
2 subtests: 32 x 8, RCB (e); 16 x 8, RCB (e)
1-row plots, 18 ft. long

Planted: October 5, 1994
Harvested: May 25, 1995

Code	Variety	Source	Acre Yield		Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
			Sugar Lbs	Beets Tons					
B895-1: Area 5 RZM entries: 32 varieties x 8 reps, RCB (equalized)									
5	4CG6580	Betaseed	8583	28.65	14.9	122	0.0	95.9	123
9	2J0179	Betaseed	8472	26.10	16.1	115	0.0	95.5	97
24	2J0152	Betaseed	8407	30.38	13.8	111	0.0	97.0	205
21	H92326	Spreckels	8177	28.99	14.1	119	0.5	95.1	190
30	94HX33	Holly	7794	29.33	13.2	117	0.0	97.1	182
15	SSNB2R2	Spreckels	7774	29.07	13.4	121	0.0	94.7	235
28	H93694	Spreckels	7739	28.10	13.7	120	0.0	95.9	116
13	94HX30	Holly	7728	28.93	13.3	124	0.5	96.4	219
31	HM3048	Hilleshog	7653	27.13	14.0	123	0.0	95.1	188
10	2J5088	Betaseed	7582	26.14	14.4	121	0.0	96.9	171
7	94HX34	Holly	7549	27.40	13.7	122	1.1	96.1	172
16	Beta 4581	Betaseed	7534	28.42	13.2	129	0.0	95.9	256
20	94HX31	Holly	7469	26.85	13.8	117	0.0	96.5	206
8	4CG6583	Betaseed	7448	25.61	14.6	112	0.0	94.8	124
26	SS-781R	Spreckels	7442	28.37	13.1	116	0.0	96.2	177
12	HH-97R	Holly	7376	27.43	13.4	135	0.0	96.1	117
2	4CG6574	Beta	7359	26.01	14.2	95	0.0	97.2	160
3	94HX32	Holly	7357	27.11	13.6	111	0.0	97.1	165
23	94HX22	Holly	7299	27.11	13.4	117	0.0	97.4	149
11	HM 3013	Check	7289	27.34	13.3	115	0.0	93.3	125
19	HH-102R	Holly	7281	27.75	13.0	130	0.0	95.5	225
17	SS-IV2	Check	7171	28.66	12.5	124	0.0	95.1	146
4	Beta 4684	Check	6955	26.55	13.0	123	0.0	94.6	150
22	Rhizoguard	Holly	6885	25.93	13.2	120	0.0	96.1	136

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS
UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95

(cont.)

Code	Variety	Source	Acre Yield			Beets/ 100'	Bolters %	Clean Beets %	NO3-N Mean
			Sugar Lbs	Beets Tons	Sucrose %				

B895-1: Area 5 RZM entries: 32 varieties x 8 reps, RCB (equalized) (cont.)

27	SS-NB2R	Spreckels	6739	26.80	12.6	120	0.0	93.7	223
6	HM 3047	Hilleshog	6715	25.89	13.0	118	0.0	95.9	199
18	Rhizosen Plus	Holly	6627	25.24	13.1	111	2.0	95.5	191
29	SS-287R	Spreckels	6385	24.29	13.1	123	0.0	94.2	190
25	Rhizosen	Holly	6182	23.43	13.1	126	17.4	95.5	140
1	HH-101R	Holly	6052	25.05	12.0	121	0.0	95.9	220
14	US H11	Check	5665	23.36	12.0	120	0.0	92.7	171
32	US H11	USDA	5536	22.74	12.2	126	0.0	92.0	176
Mean			7257.0	26.88	13.4	119.6	0.7	95.5	173.1
LSD (.05)			965.8	3.31	0.9	11.5	1.6	1.4	63.5
C.V. (%)			13.5	12.51	6.9	9.8	247.4	1.5	37.2
F value			4.6**	2.41**	6.6**	2.9**	27.4**	6.6**	3.0**

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95. 48 entries x 8 replications, RCB (equalized). ANOVA to compare means across sets of entries.

Mean			7378.9	27.43	13.4	119.8	0.5	95.3	172.6
LSD (.05)			1002.5	3.38	0.9	11.8	1.5	1.5	62.2
C.V. (%)			13.8	12.50	6.5	10.0	280.8	1.6	36.6
F value			3.3**	3.32**	6.3**	2.2*	23.4**	5.0**	2.7**

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS
UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 94-95

(cont.)

Code	Variety	Source	Acre Yield		Sucrose	Beets/ 100'	Bolters	Clean	NO3-N
			Lbs	Tons		No.	%	%	Mean

B895-2: USDA entries: 16 varieties x 8 replications, RCB (equalized)

38	R476-43-15H50	USDA	8254	30.44	13.5	126	0.0	95.6	204
36	R484H50	USDA	8095	28.22	14.2	111	0.0	95.1	160
37	R476-43-14H50	USDA	8053	29.31	13.7	125	0.0	96.5	200
34	R422R4H52	USDA	8006	32.80	12.2	120	3.4	95.0	225
42	4911-4H52	USDA	7886	30.14	12.9	122	0.0	94.4	168
40	R476-89-18H50	USDA	7809	28.21	13.7	120	0.0	95.5	144
48	4915-34H52	USDA	7554	27.71	13.6	114	0.0	94.5	133
45	4915-6H52	USDA	7498	26.94	13.9	125	0.0	92.9	147
41	4918H52	USDA	7492	29.37	12.7	122	0.0	94.4	223
43	4913-6H52	USDA	7438	29.14	12.7	115	0.0	94.4	151
47	4915-22H52	USDA	7409	29.20	12.6	120	0.0	93.9	202
39	R476-89-5H50	USDA	7373	25.41	14.5	117	0.0	95.1	147
33	HH41	USDA	7353	28.24	12.9	127	0.0	95.4	156
44	4913-9H52	USDA	7338	27.80	13.1	121	0.0	94.5	168
46	4915-7H52	USDA	7259	26.56	13.7	120	0.0	93.8	131
35	4915-H93	USDA	7147	26.79	13.4	119	0.5	95.2	185
Mean			7622.8	28.52	13.3	120.1	0.3	94.8	171.5
LSD (.05)			1012.4	3.46	0.7	12.8	1.1	1.7	58.3
C.V. (%)			13.4	12.26	5.3	10.8	439.5	1.8	34.3
F value			0.9NS	2.06*	6.1**	0.9NS	4.9**	2.0*	2.2*

H50 = C790-15CMS as female parent. H52 = C762-17CMS x C790-15 as female parent.

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS
UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH ₄ -N ppm	Impur. Value
B895-1: Area 5 RZM entries: 32 varieties x 8 reps, RCB (equalized)									
5	4CG6580	7402	258	86.3	1181	562	2582	549	13639
9	2J0179	7441	283	87.8	1031	489	2444	554	13081
24	2J0152	7198	237	85.5	1209	1108	2384	366	13314
21	H92326	7136	245	87.0	1040	872	2263	362	12147
30	94HX33	6737	228	86.0	1056	850	2244	376	12156
15	SSNB2R2	6553	225	84.2	1221	742	2385	583	14099
28	H93694	6627	234	85.5	1112	693	2533	472	13236
13	94HX30	6533	226	84.4	1194	890	2503	456	13706
31	HM3048	6619	244	86.9	1034	713	2435	400	12378
10	2J5088	6572	249	86.8	1009	700	2180	504	12685
7	94HX34	6600	240	87.2	949	693	2261	370	11586
16	Beta 4581	6154	217	81.9	1379	773	2836	649	15955
20	94HX31	6403	236	85.3	1066	843	2675	391	13354
8	4CG6583	6591	258	88.6	857	483	2290	385	11075
26	SS-781R	6349	224	85.3	1093	756	2520	408	12817
12	HH-97R	6451	235	87.3	925	741	2326	301	11269
2	4CG6574	6206	241	84.6	1153	635	2636	596	14473
3	94HX32	6276	232	85.3	1080	704	2452	488	13230
23	94HX22	6292	231	85.9	1007	791	2666	321	12486
11	HM 3013	6310	229	86.5	979	884	2482	279	11948
19	HH-102R	6212	223	85.6	1070	900	2404	349	12473
17	SS-IV2	6068	211	84.6	1103	982	2573	307	12782
4	Beta 4684	5947	223	85.5	1008	931	2387	351	12557
22	Rhizoguard	5871	225	84.9	1014	867	2469	414	13140

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS
UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH ₄ -N ppm	Impur. Value
B895-1: Area 5 RZM entries: 32 varieties x 8 reps, RCB (equalized) (cont.)									
27	SS-NB2R	5609	210	83.0	1130	842	2564	480	13920
6	HM 3047	5438	211	81.2	1276	889	2735	666	16275
18	Rhizosen Plus	5684	225	85.5	943	909	2164	410	12482
29	SS-287R	5317	220	83.3	1068	884	2844	435	14342
25	Rhizosen	5470	231	88.1	713	888	1993	224	10215
1	HH-101R	5016	198	82.7	1036	1136	2550	353	13700
14	US H11	4803	204	84.4	862	678	2666	330	12169
32	US H11	4644	204	83.7	892	971	2728	300	13069
Mean		6204.0	229.9	85.3	1052.9	806.2	2474.1	419.5	12992.5
LSD (.05)		878.2	20.5	2.9	232.2	211.3	403.9	109.7	2161.0
C.V. (%)		14.4	9.1	3.5	22.4	26.6	16.6	26.5	16.9
F value		4.8**	5.6**	2.8**	2.5**	4.0**	1.9**	7.7**	2.6**

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95. 48 entries x 8 replications, RCB (equalized). ANOVA to compare means across sets of entries.

Mean	6313.1	229.3	85.4	1065.7	810.5	2500.2	403.5	12921.0
LSD (.05)	924.5	19.6	2.9	231.4	232.4	404.1	109.7	2209.7
C.V. (%)	14.9	8.7	3.5	22.0	29.1	16.4	27.6	17.4
F value	3.4**	5.4**	2.5**	2.3**	2.6**	2.0**	5.8**	2.0**

TEST B895. AREA 5 CODED RHIZOMANIA TRIAL & USDA EXPERIMENTAL HYBRIDS
UNDER MILD TO MODERATE RHIZOMANIA, BRAWLEY, CA., 1994-95

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH ₃ -N ppm	Impur. Value
<u>B895-2: USDA entries: 16 varieties x 8 replications, RCB (equalized)</u>									
38	R476-43-15H50	7109	231	85.7	1145	790	2436	404	12696
36	R484H50	7072	249	87.3	1023	767	2270	384	12010
37	R476-43-14H50	7037	239	87.0	1016	819	2209	355	11755
34	R422R4H52	6713	204	83.8	1292	797	2528	422	13115
42	4911-4H52	6582	215	83.2	1304	937	2912	401	14370
40	R476-89-18H50	6844	239	87.1	965	746	2535	293	11731
48	4915-34H52	6495	234	85.9	1059	724	2740	353	12737
45	4915-6H52	6519	241	86.7	979	767	2562	327	12197
41	4918H52	6324	215	84.3	1169	869	2474	419	13207
43	4913-6H52	6264	214	84.1	1174	944	2786	339	13486
47	4915-22H52	6184	211	83.2	1225	975	2817	370	13969
39	R476-89-5H50	6451	253	87.2	922	736	2245	419	12165
33	HH41	6308	221	85.4	1045	995	2424	301	12403
44	4913-9H52	6233	222	84.9	1105	822	2667	381	13164
46	4915-7H52	6278	237	86.5	981	668	2535	380	12281
35	4915-H93	6088	228	85.2	1059	753	2699	398	13164
Mean		6531.3	228.3	85.5	1091.4	819.2	2552.4	371.6	12778.1
LSD (.05)		938.3	16.8	2.8	231.7	223.1	416.8	106.8	2204.8
C.V. (%)		14.5	7.4	3.3	21.4	27.5	16.5	29.0	17.4
F value		1.0NS	5.6**	2.1*	2.0*	1.5NS	2.0*	1.1NS	1.0NS

TEST B595. CARRY-OVER EFFECTS OF SOLARIZATION AND FUMIGATION ON PERFORMANCE OF SUGARBEET,
BRAWLEY, CA., 1994-95

1 variety x 4 soil trtmts x 4 reps, Split-Plot
2-row plots, 30 ft. long

Planted: October 19, 1995
Harvested: May 20 & July 6, 1995

Treatment	Acre Yield		Sucrose	Stand	Harvest	Clean	NO3-N	Beets/	Root
	Sugar Lbs	Beets Tons	%	Count No.	Count No.	%	Mean	100'	Rot %
1. Control	1880	6.22	14.57	96	56	81.1	32	160	43.9
2. Solarization	3727	11.03	16.74	97	82	93.9	10	162	15.4
3. Vapam	1546	5.14	14.33	93	54	78.0	32	155	43.0
4. Methylbromide	5474	16.78	16.33	97	87	91.0	11	162	10.4
<u>Harvest Date (H)</u>									
1. May 20, 1995	3886	11.25	16.93	95	85	91.2	16	159	10.3
2. July 6, 1995	2427	8.33	14.06	97	54	80.8	27	161	46.0
<u>S x H</u>									
1 x 1	2809	8.83	15.81	97	80	93.2	26	161	18.4
1 x 2	951	3.62	13.34	96	32	69.0	39	160	69.3
2 x 1	4404	11.92	18.49	96	93	93.4	7	160	3.7
2 x 2	3050	10.14	14.99	98	71	94.4	13	163	27.0
3 x 1	2164	6.68	15.74	96	80	84.2	22	161	16.4
3 x 2	929	3.61	12.93	90	27	71.8	41	150	69.6
4 x 1	6168	17.59	17.67	92	89	93.9	8	153	2.8
4 x 2	4779	15.97	14.99	103	84	88.0	13	172	17.9
<u>Grand Mean</u>									
C.V. (%) - S x H	3156.7	9.79	15.49	95.8	69.4	86.0	21.2	159.9	28.1
LSD (.05) - S	25.4	26.12	5.90	7.3	19.7	30.5	88.4	7.4	42.7
LSD (.05) - H	1157.0	3.99	1.17	18.0	24.1	24.0	26.3	30.0	16.8
LSD (.05) - S x H	**	**	**	NS	**	NS	NS	NS	**
F value - S	1235.0	3.94	1.41	10.8	21.0	40.4	28.9	18.1	18.5
F value - H	25.3**	18.12**	11.04**	0.1NS	5.2*	1.0NS	2.3NS	0.1NS	11.5**
F value - S x H	26.5**	10.43**	78.69**	0.3NS	43.3**	1.2NS	2.5NS	0.3NS	70.5**
F value - S x H	0.2NS	0.8NS	0.48NS	2.2NS	5.6*	0.3NS	0.2NS	2.2NS	5.2*

NOTES: Test B595 was planted only to HH41 and was superimposed over test B594 grown in 1994 (see pages A128-A134 in 1994 Report). Soil treatments were the ones established for the 1994 crop. Test B595 ran short of nitrogen, so yields were low. The purpose of test B595 was to determine if the costs of soil treatments could be amortized over multiple years and crops. This test was grown in cooperation with Dr. Anne F. Wrona, U.C. Extension, Imperial County, California.

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

4 soil trtms x 4 var. x 2 harv. dates x 4 reps, Split-Split Plot
1-row plots, 30 ft. long

Planted: October 19, 1995
Harvested: May 20 & July 6, 1995

Treatment	Acre Yield		Sucrose %	Stand		Harvest Count	Clean Beets %	NO3-N Mean	Root Rot %	Bolters %
	Sugar	Beets		Count	No.					
	Lbs	Tons								
Soil Treatments (S)										
1. Control	5534	20.34	13.58	44	39	91.3	125.55	12.5	0.6	
2. Solarization	9202	32.72	14.15	45	45	94.0	116.85	0.8	0.3	
3. Vapam	7026	26.09	13.58	44	42	93.6	106.55	4.6	0.3	
4. Methylbromide	8272	29.45	14.18	44	44	94.3	110.44	0.4	0.5	
Varieties (V)										
1. HH 41	7172	26.28	13.51	48	44	92.0	102.94	7.6	0.0	
2. Rhizoguard	6934	24.32	14.30	46	45	94.9	94.70	1.9	0.0	
3. 4915H93	7137	25.13	14.25	41	39	93.7	100.54	5.9	0.2	
4. R422R4H52	8791	32.87	13.43	44	43	92.6	161.22	2.9	1.5	
Harvest Date (H)										
1. May 20, 1995	7447	25.06	14.92	44	43	94.2	116.26	2.6	0.4	
2. July 6, 1995	7570	29.24	12.83	45	42	92.4	113.44	6.6	0.4	
S x V										
1 x 1	4259	16.33	12.80	44	35	90.5	120.00	20.7	0.0	
1 x 2	5070	18.30	13.89	46	40	93.1	104.46	12.3	0.0	
1 x 3	5323	18.41	14.39	44	39	91.3	86.88	10.5	0.8	
1 x 4	7483	28.31	13.24	44	42	90.3	190.88	6.6	1.6	
2 x 1	9838	34.86	14.20	48	48	91.1	112.00	-0.4	0.0	
2 x 2	8779	30.46	14.46	47	48	95.8	107.33	-1.7	0.0	
2 x 3	8756	30.97	14.21	40	38	95.3	112.17	4.6	0.0	
2 x 4	9435	34.59	13.72	46	46	93.7	135.92	0.6	1.3	
3 x 1	6231	24.24	12.96	48	45	92.7	79.04	7.6	0.0	
3 x 2	6180	22.12	14.14	46	45	94.8	77.58	3.4	0.0	
3 x 3	6750	24.23	13.95	38	37	93.6	96.38	4.3	0.0	
3 x 4	8943	33.79	13.27	44	43	93.3	173.21	3.1	1.0	
4 x 1	8359	29.70	14.09	50	48	93.9	100.71	2.4	0.0	
4 x 2	7706	26.38	14.68	44	47	95.7	89.42	-6.4	0.0	
4 x 3	7720	26.91	14.46	43	41	94.3	106.75	4.4	0.0	
4 x 4	9303	34.80	13.48	41	40	93.4	144.88	1.2	2.1	

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

(cont.)

Treatment	Acre Yield			Stand		Harvest		Clean		NO3-N		Root	
	Sugar	Beets	Sucrose	Count	Count	Count	Beets	Mean	Rot	Bolters			
	Lbs	Tons	%	No.	No.	No.	%		%	%			
S x H	6029	20.44	14.85	44	42		93.1	137.88	5.5	0.2			
	5039	20.23	12.31	45	36		89.5	113.23	19.6	1.0			
	8771	29.59	14.85	45	44		94.7	107.54	2.1	0.5			
	9633	35.85	13.45	46	46		93.2	126.17	-0.5	0.1			
	6924	23.66	14.74	45	44		94.3	119.02	1.8	0.4			
	7128	28.52	12.43	43	40		92.9	94.08	7.4	0.2			
	8062	26.54	15.23	44	44		94.6	100.60	0.9	0.6			
	8482	32.35	13.12	45	45		94.1	120.27	-0.1	0.5			
V x H	7587	25.68	14.76	47	47		93.2	103.38	0.9	0.0			
	6757	26.89	12.27	48	41		90.9	102.50	14.2	0.0			
	6870	22.34	15.40	45	45		95.6	91.81	-0.2	0.0			
	6998	26.29	13.19	47	45		94.1	97.58	4.0	0.0			
	7033	22.90	15.37	42	40		94.3	97.33	5.5	0.0			
	7242	27.36	13.13	40	38		93.0	103.75	6.4	0.4			
	8297	29.32	14.14	44	42		93.7	172.52	4.1	1.7			
	9285	36.42	12.72	44	43		91.6	149.92	1.6	1.3			
S x V x H	5558	19.56	14.33	42	41		91.8	123.75	1.7	0.0			
	2961	13.12	11.27	47	28		89.1	116.25	39.6	0.0			
	5490	17.97	15.34	43	42		94.6	111.58	2.8	0.0			
	4651	18.64	12.45	49	38		91.6	97.33	21.8	0.0			
	5583	17.90	15.61	44	41		93.4	87.67	7.8	0.0			
	5064	18.92	13.18	43	38		89.3	86.08	13.1	1.7			
	7488	26.37	14.14	46	43		92.7	228.5	9.6	1.0			
	7479	30.26	12.34	43	41		87.8	153.25	3.7	2.3			
	9768	32.80	14.98	44	44		93.6	98.75	-0.7	0.0			
	9908	36.91	13.42	53	53		88.7	125.25	-0.1	0.0			
	8389	27.57	15.20	47	48		96.0	101.42	-1.1	0.0			
	9170	33.35	13.73	48	49		95.6	113.25	-2.2	0.0			
	8403	28.08	14.97	41	39		95.2	103.92	5.4	0.0			
	9109	33.87	13.46	38	37		95.4	120.42	3.8	0.0			

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

(cont.)

Treatment	Acre Yield			Sucrose %	Stand		Harvest Count	Clean Beets %	NO3-N Mean	Root	
	Sugar Lbs	Beets Tons	Count		No.	Rot %				Bolters %	
(cont.)											
S x V x H (cont.)											
2 x 4 x 1	8526	29.90	14.25	46	44	94.1	126.08	4.8	2.2		
2 x 4 x 2	10343	39.28	13.19	46	47	93.2	145.75	-3.6	0.5		
3 x 1 x 1	6305	21.63	14.54	52	50	93.1	87.50	3.0	0.0		
3 x 1 x 2	6158	26.84	11.38	45	39	92.3	70.58	12.2	0.0		
3 x 2 x 1	6112	20.46	15.15	46	46	95.8	83.17	-1.3	0.0		
3 x 2 x 2	6247	23.78	13.13	47	43	93.8	72.00	8.1	0.0		
3 x 3 x 1	6677	21.74	15.31	38	36	94.2	104.58	4.2	0.0		
3 x 3 x 2	6822	26.71	12.60	39	38	93.1	88.17	4.4	0.0		
3 x 4 x 1	8603	30.82	13.95	46	45	94.2	200.83	1.3	1.4		
3 x 4 x 2	9283	36.76	12.60	43	41	92.3	145.58	4.9	0.6		
4 x 1 x 1	8719	28.73	15.18	51	52	94.1	103.40	-0.4	0.0		
4 x 1 x 2	7999	30.67	13.01	48	45	93.7	97.92	5.3	0.0		
4 x 2 x 1	7488	23.37	15.93	43	43	96.1	71.08	-1.3	0.0		
4 x 2 x 2	7924	29.38	13.43	46	51	95.2	107.75	-11.5	0.0		
4 x 3 x 1	7468	23.87	15.61	45	43	94.5	93.17	4.5	0.0		
4 x 3 x 2	7972	29.95	13.03	41	39	94.2	120.33	4.3	0.0		
4 x 4 x 1	8572	30.20	14.21	38	38	93.6	134.67	0.8	2.3		
4 x 4 x 2	10034	39.39	12.75	44	43	93.2	155.08	1.5	1.9		
Grand Mean											
C.V. (%)	7058.5	27.15	13.87	44.6	42.5	93.3	114.85	4.6	0.4		
LSD (.05)	9.8	9.85	3.27	10.2	13.0	2.2	26.68	174.1	262.3		
LSD (.05)	584.6	2.23	0.37	2.9	3.3	1.3	21.6	5.1	0.5		
LSD (.05)	584.6	2.23	0.37	2.9	3.3	1.3	21.6	5.1	0.5		
LSD (.05)	NS	**	**	NS	NS	**	NS	**	NS		
LSD (.05)	1169.0	4.46	0.74	5.8	6.6	2.7	43.2	10.2	0.9		
LSD (.05)	522.9	1.90	0.32	3.2	3.9	1.4	21.8	5.7	0.8		
LSD (.05)	522.9	1.90	0.32	3.2	3.9	1.4	21.8	5.7	0.8		
LSD (.05)	1046.0	3.80	0.65	6.5	7.9	2.8	43.6	11.3	1.6		
F value	60.0**	45.68**	6.65**	0.2NS	5.6**	8.6**	1.20NS	9.8**	1.0NS		
F value	17.6**	24.86**	12.74**	7.7**	5.6**	6.9**	16.81**	2.2NS	19.2**		
F value	0.9NS	78.21**	678.55**	0.2NS	2.8NS	25.4**	0.27NS	8.1**	0.0NS		
F value	2.9*	2.18*	1.53NS	1.3NS	2.2*	0.7NS	1.45NS	1.1NS	0.8NS		
F value	8.7**	9.98**	9.39**	1.2NS	4.2*	3.5*	5.49**	7.3**	1.6NS		
F value	8.2**	6.52**	8.41**	1.2NS	1.9NS	0.3NS	1.57NS	5.8**	0.7NS		
F value	0.6NS	1.02NS	1.09NS	2.2*	1.9NS	1.0NS	0.86NS	2.6*	0.6NS		

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

(cont.)

Treatment	Recover.		Recover.		Known SugarLoss lbs/a	Sodium		Potassium		NH ₄ -N		Impur. Value
	Sugar lbs/a	Sugar lbs/t	Sugar %			ppm	ppm	ppm	ppm			
Soil Treatments (S)												
1. Control	4826	237	87.0		708	1111		2076		255		11504
2. Solarization	7914	244	86.1		1288	632		2496		484		13051
3. Vapam	6172	240	88.1		854	815		2075		272		10626
4. Methylbromide	7200	248	87.2		1072	705		2343		384		11967
Varieties (V)												
1. HH 41	6290	237	87.5		882	905		2118		276		11082
2. Rhizoguard	6121	253	88.4		813	846		2021		312		10979
3. 4915H93	6245	250	87.6		892	772		2295		333		11603
4. R422R4H52	7456	228	84.8		1335	739		2555		475		13484
Harvest Date (H)												
1. May 20, 1995	6558	264	88.2		889	684		2348		352		11607
2. July 6, 1995	6499	221	85.9		1072	948		2147		346		11967
S x V												
1 x 1	3714	222	86.4		545	1328		2008		178		11363
1 x 2	4495	246	88.3		575	1187		1853		197		10658
1 x 3	4726	255	88.5		597	989		2071		233		10854
1 x 4	6370	225	84.9		1113	940		2372		413		13141
2 x 1	8530	247	86.7		1308	663		2342		450		12452
2 x 2	7644	252	87.1		1135	649		2304		457		12372
2 x 3	7542	245	86.2		1214	609		2598		463		13027
2 x 4	7940	231	84.2		1495	607		2738		567		14354
3 x 1	5541	231	88.8		691	885		1924		165		9472
3 x 2	5501	253	89.2		678	820		1898		257		10057
3 x 3	5989	248	88.7		760	786		2059		250		10275
3 x 4	7655	227	85.5		1288	768		2420		417		12702
4 x 1	7377	249	88.2		982	743		2199		310		11043
4 x 2	6843	261	88.8		863	729		2031		337		10831
4 x 3	6721	252	87.1		999	704		2451		386		12257
4 x 4	7860	228	84.5		1443	643		2689		502		13739

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

(cont.)

Treatment (cont.)		Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH ₄ -N ppm	Impur. Value
S x H	1 x 1	5328	263	88.5	702	943	2186	269	11321
	1 x 2	4325	211	85.6	714	1279	1965	242	11686
	2 x 1	7623	258	86.9	1148	561	2594	469	12902
	2 x 2	8204	229	85.2	1428	703	2397	500	13201
	3 x 1	6161	263	89.3	763	658	2163	289	10457
	3 x 2	6182	216	86.9	945	972	1987	255	10795
	4 x 1	7118	269	88.3	944	573	2449	381	11749
	4 x 2	7283	226	86.0	1200	837	2237	386	12186
V x H	1 x 1	6724	262	88.8	864	729	2238	303	11026
	1 x 2	5857	212	86.3	900	1081	1999	248	11138
	2 x 1	6145	276	89.5	725	662	2137	325	10747
	2 x 2	6097	230	87.2	901	1031	1906	299	11212
	3 x 1	6233	273	88.9	799	627	2379	340	11366
	3 x 2	6257	227	86.4	985	917	2211	327	11840
	4 x 1	7128	243	85.8	1169	716	2638	441	13290
	4 x 2	7784	213	83.8	1501	763	2471	508	13678
S x V x H	1 x 1 x 1	4916	253	88.3	642	1094	2118	212	11139
	1 x 1 x 2	2513	191	84.5	448	1562	1897	145	11586
	1 x 2 x 1	4953	276	90.1	536	937	1964	208	10167
	1 x 2 x 2	4037	216	86.6	615	1438	1742	185	11149
	1 x 3 x 1	5008	280	89.8	574	819	2152	249	10608
	1 x 3 x 2	4444	230	87.2	619	1160	1990	217	11099
	1 x 4 x 1	6433	243	85.7	1055	923	2512	407	13372
	1 x 4 x 2	6308	208	84.2	1171	957	2232	419	12911
	2 x 1 x 1	8555	263	87.7	1213	563	2457	433	12227
	2 x 1 x 2	8505	230	85.8	1403	764	2228	467	12677
	2 x 2 x 1	7402	268	88.2	987	546	2349	435	11919
	2 x 2 x 2	7886	236	86.0	1284	753	2260	478	12826
	2 x 3 x 1	7271	259	86.5	1132	519	2756	497	13427
	2 x 3 x 2	7814	231	85.9	1296	699	2440	430	12627

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

(cont.)

Treatment (cont.)		Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH ₄ -N ppm	Impur. Value
S x V x H (cont.)									
2 x 4 x 1		7266	243	85.2	1260	616	2815	509	14034
2 x 4 x 2		8614	220	83.3	1729	598	2661	624	14674
3 x 1 x 1		5702	263	90.5	603	656	1994	199	9167
3 x 1 x 2		5380	198	87.0	778	1114	1855	131	9777
3 x 2 x 1		5481	272	89.7	631	676	2084	291	10336
3 x 2 x 2		5522	233	88.7	725	964	1712	224	9778
3 x 3 x 1		6024	277	90.4	653	555	2131	260	9733
3 x 3 x 2		5955	220	87.0	868	1018	1988	241	10818
3 x 4 x 1		7438	241	86.4	1165	744	2445	408	12594
3 x 4 x 2		7872	214	84.7	1411	791	2395	427	12809
4 x 1 x 1		7722	269	88.5	996	604	2384	369	11574
4 x 1 x 2		7031	229	87.9	968	883	2015	251	10512
4 x 2 x 1		6743	287	90.1	746	491	2153	365	10566
4 x 2 x 2		6943	235	87.6	981	967	1909	309	11095
4 x 3 x 1		6629	277	88.7	839	615	2476	353	11697
4 x 3 x 2		6814	228	85.5	1158	792	2427	419	12817
4 x 4 x 1		7377	245	86.0	1195	581	2781	440	13160
4 x 4 x 2		8343	212	83.1	1691	705	2598	564	14318
Grand Mean		6528.1	242.1	87.1	980.4	815.7	2247.4	348.8	11787.2
C.V. (%)	- S x V x H	10.0	4.2	1.4	12.0	16.9	6.7	15.9	7.4
LSD (.05)	- S	528.4	8.3	0.9	87.9	121.6	96.8	38.1	587.0
LSD (.05)	- V	528.4	8.3	0.9	87.9	121.6	96.8	38.1	587.0
LSD (.05)	- H	NS	**	**	**	**	**	NS	*
LSD (.05)	- S x V	1057.0	16.6	1.7	175.8	243.1	193.5	76.1	1174.0
LSD (.05)	- S x H	463.4	7.3	0.9	83.9	97.8	106.8	39.4	618.7
LSD (.05)	- V x H	463.4	7.3	0.9	83.9	97.8	106.8	39.4	618.7
LSD (.05)	- S x V x H	926.7	14.5	1.7	167.7	195.6	213.7	78.8	1237.0
F value	- S	52.3**	2.5NS	7.3**	67.6**	24.4**	37.5**	63.7**	24.0**
F value	- V	11.3**	15.9**	26.4**	59.8**	3.0*	47.5**	42.5**	31.9**
F value	- H	0.3NS	562.9**	113.5**	76.5**	118.0**	57.4**	0.4NS	5.5*
F value	- S x V	2.9**	1.4NS	1.1NS	1.7NS	0.7NS	0.9NS	1.2NS	1.0NS
F value	- S x H	8.5**	7.5**	1.2NS	8.4**	3.2*	0.1NS	2.3NS	0.0NS
F value	- V x H	7.3**	6.4**	0.3NS	8.4**	9.4**	0.6NS	7.1**	0.3NS
F value	- S x V x H	0.5NS	1.4NS	1.9NS	1.5NS	1.1NS	1.2NS	2.1*	2.1*

TEST B695. SOLARIZATION AND FUMIGATION BY VARIETIES IN RHIZOMANIA INFESTED SOIL,
BRAWLEY, CA., 1994-95

(cont.)

NOTES:

% Root Rot:

Stand counts were made post thinning. Harvest counts were made during harvest. % root rot was calculated from the difference between the early stand count and the harvest count. Thus by chance, a few entries and treatments show negative % root rot.

Varieties:

HH 41 is standard check. Rhizoguard is a commercial Holly hybrid with resistance to rhizomania. 4915H93 is USDA experimental hybrid with Rz (Holly) resistance. R422R4H52 is a USDA experimental hybrid with a rhizomania susceptible female parent and a rhizomania resistant male parent with resistance derived from B. maritima (C50, R22).

Rhizomania:

Rhizomania was mild-moderate. The disease was less severe than for the similar test B594 in 1994. Test B695 was grown in an area with moderate rhizomania infestation. In addition, cyst nematode occurred. In 1993^a, soil from an adjacent rhizomania infested area was spread, worked in, and then sugarbeet grown from April to June. In 1994, variety trials were grown in this field plot area. Following harvest in the spring of 1994, the soil treatments were established. Test B695 was planted in the fall of 1994 and harvested in the spring/summer of 1995. The level of rhizomania is probably more similar to that a grower would encounter. Though not as visually dramatic as Test B594 grown in 1994, the data and interactions from B695 are probably much more representative and realistic.

Test B695 was grown in cooperation with Dr. A.F. Wrona, U.C. Extension.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1995

180 entries x 3 replications
2-row plots, 12 ft. long

Variety ⁴	Description ⁴	Stand Count	CT Grade		
			1st ¹	2nd ¹	CRT ²
		Mean	Rating	Rating	Rating
<u>HYBRIDS</u>					
US H11	L113401, F82-546H3 x C36	25	3.0	4.3	2.0
WS-PM9	4-18-95 Hilleshog-MH	23	3.0	3.7	2.2
SS-NB3	11-9-92, Spreckels	24	3.7	4.3	4.0
2J0179	9/9/94, Betaseed	19	5.3	6.3	6.5
SS-IV3	L94617, Spreckels	21	4.3	5.0	5.7
4454	4-28-95, Betaseed	24	4.0	5.0	5.0
Rhizoguard	8/30/94, Holly	20	4.3	5.0	5.3
R440H8	F82-546H3 x RZM R40(C)	21	3.3	4.0	3.3
R479H8	F82-546H3 x R379(C79-1)	20	3.7	4.0	3.5
R480-45H8	F82-546H3 x R280-45(C80-45)	21	3.7	4.3	3.1
4918H8	F82-546H3 x RZM 3918(C918)	20	4.0	4.7	4.6
R378H8	F82-546H3 x R278,Y(C78)	23	3.7	4.3	4.5
R422R5H50	F92-790-15CMS x RZM R322R4(GSY)	23	4.0	4.7	4.4
R422R5% ⁵ H50	F92-790-15CMS x RZM R322R4(%)	23	4.0	4.7	4.3
R422Y3H50	F92-790-15CMS x R322Y3	23	4.3	4.7	4.9
R422Y3% ⁵ H50	F92-790-15CMS x R322Y3(%)	24	4.0	4.7	4.0
R476-43-# ⁶ H50	F92-790-15CMS x RZM R376-43-#(C)	23	3.3	4.7	4.0
R476-43-14H50	F92-790-15CMS x RZM R376-43-14	22	4.0	5.0	4.4
R476-43-15H50	F92-790-15CMS x RZM R376-43-15	21	4.0	5.0	5.1
R476-89-# ⁶ H50	F92-790-15CMS x RZM R376-89-#(C)	23	4.0	4.7	4.2
R476-89-5H50	F92-790-15CMS x RZM R376-89-5	22	4.0	5.0	5.0
R476-89-18H50	F92-790-15CMS x RZM R376-89-18	21	3.7	4.7	4.4
R478H50	F92-790-15CMS x RZM R378,Y(C78)	23	3.7	4.3	3.1
US H11	L113401	25	3.0	4.0	2.9
R440H50	F92-790-15CMS x RZM R40(C)	21	3.7	4.3	4.0
R479H50	F92-790-15CMS x RZM R379(C79-1)	24	3.3	4.3	3.2
R480H50	F92-790-15CMS x RZM R380,Y(C80)	24	3.7	4.3	4.0
R480-45H50	F92-790-15CMS x R280-45(C80-45)	23	4.0	4.7	4.9
R481-43H50	F92-790-15CMS x RZM R381-43	14	4.3	4.7	5.3
R481-89H50	F92-790-15CMS x RZM R381-89	23	4.3	5.3	5.9
R483H50	F92-790-15CMS x RZM R383	22	3.7	4.7	4.0
Z430H50	F92-790-15CMS x RZM Z330	22	3.7	4.7	3.5
4911-4H50	F92-790-15CMS x 3911-4m	19	3.3	4.3	3.3
4913-6H50	F92-790-15CMS x 3913-6	21	3.0	4.3	2.6
4913-9H50	F92-790-15CMS x 3913-9	18	3.7	4.3	3.9
4913-70H50	F92-790-15CMS x RZM 3913-70	23	3.7	5.0	4.0
4913-71H50	F92-790-15CMS x RZM 3913-71	24	4.3	4.7	4.5
4915H50	F92-790-15CMS x RZM 3915	24	3.7	4.7	4.4
4915-6H50	F92-790-15CMS x 3915-6	23	4.3	5.0	4.9
4915-7H50	F92-790-15CMS x 3915-7	19	4.0	4.7	4.8
4915-22H50	F92-790-15CMS x 3915-22	22	3.7	4.7	4.2
4915-34H50	F92-790-15CMS x 3915-34	21	3.7	4.0	4.0
4918H50	F92-790-15CMS x RZM 3918	20	3.7	4.3	3.1
US H11	L113401	26	3.0	4.0	2.5
R480-45H52	F92-790-15H39 x R280-45	20	3.3	4.0	2.9
4911H52	F92-790-15H39 x RZM 3911	23	4.0	4.7	3.9
4916H52	F92-790-15H39 x RZM 3916	23	3.7	4.7	3.4
4917H52	F92-790-15H39 x RZM 3917	22	3.7	4.3	4.0

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1995

(cont.)

Variety ⁴	Description ⁴	Stand Count	CT Grade		
			1st ¹	2nd ¹	CRT ²
		Mean	Rating	Rating	Rating
HYBRIDS (cont.)					
4918H52	F92-790-15H39 x RZM 3918	21	3.7	4.0	4.5
R480-45H37	U84-306CMS x R280-45	20	4.0	4.7	4.9
R480-45H39	91-762-17CMS x R280-45	20	4.0	4.7	5.2
4918H37	U84-306CMS x RZM 3918	20	4.0	5.0	5.3
US H11	L113401	24	3.3	4.3	3.3
R422R4H15	3915aa x RZM R322R4, R4%	23	4.3	5.7	5.5
R422Y3H15	3915aa x R322Y3, Y3%	20	4.7	5.3	5.4
4911-4H25	5816aa x 3911-4m	20	4.7	5.3	5.4
4918H59- 1	2859mA(Sp)- 1aa x RZM 3918	17	4.3	4.7	4.3
4918H59- 2	2859mA(Sp)- 2aa x RZM 3918	20	4.0	4.7	4.0
4918H59- 8	2859mA(Sp)- 8aa x RZM 3918	19	4.0	4.3	4.6
4918H59-14	2859mA(Sp)-14aa x RZM 3918	18	3.7	4.7	4.0
4918H59-21	2859mA(Sp)-21aa x RZM 3918	18	3.7	4.3	4.9
4918H59-23	2859mA(Sp)-23aa x RZM 3918	18	4.0	4.7	5.3
4918H64- 8	3864- 8aa x RZM 3918	21	4.0	4.7	4.8
4918H64-14	3864-14aa x RZM 3918	23	3.7	5.0	4.2
4918H64-34	3864-34aa x RZM 3918	20	3.7	4.7	3.1
4918H65-21	2865mA(Sp)-21aa x RZM 3918	19	4.0	5.0	4.5
4918H67-1	2867mA(Sp)-1aa x RZM 3918	18	4.0	5.0	4.4
4918H67-6	2867mA(Sp)-6aa x RZM 3918	18	4.3	5.0	5.7
4915H93	RZM 3890m,aa x RZM 3915	21	4.3	4.7	5.8
4918H91-10	2891mA(Sp)-10 x RZM 3918	18	4.0	5.0	4.9
4918H91-16	2891mA(Sp)-16 x RZM 3918	21	4.0	5.0	4.7
4918H91-20	2891mA(Sp)-20 x RZM 3918	22	4.3	5.3	5.8
4918H91-23	2891mA(Sp)-23 x RZM 3918	19	4.3	5.3	5.4
4918H91-42	2891mA(Sp)-42 x RZM 3918	19	4.3	5.0	5.5
4911-4H90	C790aa x 3911-4m	20	4.3	5.0	5.0
MULTIGERM, O.P.					
SP 7622-0	L80466 (8/87)	22	4.7	6.7	6.9
268	Inc. 768 (US 75)	24	3.7	4.7	4.8
U86-37	C37, 86443	21	3.7	4.3	4.6
R470	RZM R370	21	4.3	5.3	5.9
R478NB	NB R278,Y,(C78)	21	4.0	5.3	4.5
R478	RZM R378,Y	23	4.0	5.0	4.3
U86-46/2	C46/2, 86342	19	4.3	5.0	5.1
R480NB	NB R280,Y,(C80NB)	18	4.7	5.7	5.8
R480-#	RZM-ER R280-#(C),(C80)	20	4.7	6.0	5.7
R480	RZM R380,Y	21	4.7	6.0	5.8
R480-45(Iso)	RZM-ER R280-45,(C80-45)	23	5.0	6.0	6.3
R480-45(Sp)	Inc. R280-45	23	5.0	5.7	5.7
Y339	YR-ER-PMR Y139,(C39)	21	4.7	6.0	6.0
R483	RZM R383(R)	23	4.7	5.7	5.4
Y347	YR-ER-PMR Y147,(C47)	23	4.3	5.7	5.4
Y462	Y#rr(C) x RZM R#(C)	20	4.3	5.7	5.5
F86-31/6	C31/6, 86263	20	5.0	6.3	6.6
R476	RZM R376,Y	23	4.0	5.3	5.0

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1995

(cont.)

Variety ⁴	Description ⁴	Stand Count	CT Grade		
			1st ¹	2nd ¹	CRT ²
		Mean	Rating	Rating	Rating
<u>MULTIGERM, O.P.</u> (cont.)					
R481-43	RZM R381-43	24	4.3	5.7	5.3
R481-89	RZM R381-89	21	4.3	5.7	5.9
R482NB	NB R276-43,-89, (C82)	22	4.7	5.7	6.0
R484	RZM R384	22	5.3	6.0	5.9
R476-43-#	RZM R376-43-#(C), (C76-43)	22	4.7	5.7	5.5
R476-89-#	RZM R376-89-#(C), (C76-89)	22	4.3	5.3	5.1
R476-43-14	RZM R376-43-14, (C76-43-14)	23	4.3	5.7	6.2
R476-43-15	RZM R376-43-15, (C76-43-15)	20	5.0	6.0	6.9
R476-89-5	RZM R376-89-5, (C76-89-5)	19	5.0	5.7	6.8
R476-89-18	RZM R376-89-18, (C76-89-18)	22	4.7	5.7	6.2
U86-37	C37, 86443	22	4.3	5.0	4.6
R479 (Iso)	RZM R379; C79-1(Rz)	21	3.7	4.7	4.6
R424	RZM 3250,P; C79-2 (WB41)	22	3.3	4.0	3.5
R425	RZM 3251,P; C79-3 (WB42)	21	3.7	4.3	4.7
R428	RZM 3202,P; C79-4 (PI07)	23	3.0	4.3	4.2
R432	RZM 3201,P; C79-5 (R04)	19	3.7	4.7	5.2
R434	RZM 3245,P; C79-6 (R05)	20	4.0	4.7	5.7
R435	RZM 3242; C79-7 (SES)	20	4.0	5.0	6.0
R436	RZM 3243,P; C79-8 (R22)	22	3.7	4.3	4.4
R436R2	RZM R336	20	4.0	5.0	4.8
R437	RZM 3247,P; C79-9 (WB151)	21	3.7	4.3	4.3
R441	RZM 3248,P; C79-10 (WB169)	23	3.3	4.3	3.8
R442	RZM 3249,P; C79-11 (WB258)	22	4.0	4.7	5.0
R443	RZM 3284,5,P (R81-89 x R22)	21	4.3	5.3	5.4
R444	RZM 3287 (2915aa x R22)	22	3.7	5.0	4.9
U86-37	C37, 86443	20	3.7	4.3	4.8
R422R5	RZM R322R4(GSY)	20	5.3	6.7	6.7
R422R5%	RZM R322R4(%)	20	5.0	6.3	5.9
R422Y3 (Iso)	Inc. R322Y3	21	4.0	5.3	5.5
R422Y3% (Iso)	Inc. R322Y3(%)	20	4.0	5.3	5.0
R440-1	U86-37 x RZM R40 (C)	18	4.0	4.3	4.2
<u>MULTIGERM, S¹, A:aa POPNS & LINES</u>					
R409	CR-RZM R209-#(C)	21	4.0	4.7	4.7
R410	CR-RZM R210-#(C)	19	4.7	6.0	5.5
P402NR	NR P202	23	4.0	4.7	5.3
P403	PMR 2211-#(C)	22	3.3	4.3	4.3
P404	PMR 2212-#(C)	21	3.7	4.7	4.4
P405	PMR 2219-#(C)	18	4.0	4.7	5.5
N444	NR-RZM N344-#X(C), (BC ₁ F ₄)	18	4.3	6.3	6.2
N454	NR-RZMN354, (BC ₂ F ₂)	19	4.3	5.3	6.0
N457	NR-RZM N357,8-#(C), (C608)	20	4.3	5.0	5.5
N461	NR-RZM N361-2-#(C), (C609)	19	4.7	5.0	5.3
Z430	RZM Z330	20	4.7	6.0	5.9
4911	RZM 3911	20	4.7	5.7	6.1

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1995

(cont.)

Variety ⁴	Description ⁴	Stand Count	CT Grade		
			1st ¹	2nd ¹	CRT ²
		Mean	Rating	Rating	Rating
<u>MULTIGERM, S^f, A:aa POPNS & LINES (cont.)</u>					
4911-4M	3911-4m, aa x A	19	4.0	5.3	5.9
4915NB	NB 2915(Sp)	16	4.0	5.0	5.7
5747	4747aa x A	19	4.0	4.7	5.7
4909-4915-#(C)	Composited ♂	18	4.3	5.3	5.8
4911-4-#(C)	Composited ♂	16	4.7	5.7	5.5
4915-#(C)	Composited ♂	20	4.0	4.7	5.4
4911-4mA	Inc. 3911-4mA	22	4.0	4.7	5.0
4915(Sp)	RZM 3915aa x A	21	3.7	4.7	4.2
4916	RZM 3916	21	3.3	4.3	3.9
4917	RZM 3917	20	3.7	4.7	4.3
4918	RZM 3918aa x A (C918)	19	3.7	4.7	4.3
4913-6	3913-6aa x A	20	3.7	4.3	4.1
4913-9	3913-9aa x A	24	4.0	5.0	4.2
4913-70	RZM 3913-70	24	4.3	5.3	5.6
4913-71	RZM 3913-71	21	4.3	4.7	5.2
4915-6	3915-6aa x A	21	4.3	5.0	5.4
4915-7	3915-7aa x A	16	4.3	5.0	5.9
4915-22	3915-22aa x A	20	4.0	4.7	5.5
4915-34	3915-34aa x A	21	4.0	4.7	4.7
<u>MONOGERM, S^f, A:aa POPNS & LINES</u>					
U86-37	86443, C37	22	3.3	4.0	4.5
4831	3911-4m,mmaa x mm,O-T(C)	22	3.7	4.7	4.5
4832	2915H90,...,2890H15aa x "	22	3.7	4.3	4.4
4833	RZM 3867m(Sp)aa x "	20	3.7	4.3	5.0
4834	RZM 3894m,aa x "	19	4.0	5.0	5.5
4893	RZM 3893, (Rzaa x mm,O-T(C))	22	4.0	5.0	5.3
F82-546H3	C562HO x C546 (82460)	22	3.7	4.0	4.4
4894	RZM 3894m	22	3.7	4.0	4.1
4895	RZM 3280,...,3282	20	4.3	4.3	4.6
4859m	RZM 3859mmaa x A(C859)	17	4.0	5.0	5.0
4890	RZM 3890mmaa x A(C890)	21	3.7	4.3	4.8
4865NB	NB 2865m(Sp) (%S) (A,aa)	22	4.3	6.0	6.6
4865m	RZM 3865,2866mmaa x A	17	4.0	5.0	5.1
<u>MONOGERM LINES</u>					
4865-4	Inc. 2865mA(Sp)-4	22	4.7	5.7	6.2
4867-1	Inc. 2867mA(Sp)-1	20	3.7	4.3	3.9
4891-4	Inc. 2891mA(Sp)-4	20	4.7	4.7	5.1
4807	Inc. 9807 (C306)	18	4.0	4.3	4.5
F92-790-15	Inc. C790-15	18	4.0	4.7	4.5
4790-15	NB F92-790-15	20	4.0	5.7	5.7
4790-15-#(C)	Inc. 2790-15-#'s	21	4.3	5.3	5.6
4790-15-23	Inc. 2790-15-23	18	4.0	5.3	5.9
4790-15-21	Inc. 2790-15-21	18	4.7	5.3	5.2
F82-562	Inc. C562 (82196)	8	4.0	4.3	5.0
F82-546	Inc. C546 (82372)	18	3.3	4.0	3.9
91-762-17CMS	10-22-91, Inc. C762-17CMS	22	3.3	4.0	2.2

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1995

(cont.)

Variety ⁴	Description ⁴	Stand Count	CT Grade		
			1st ¹	2nd ¹	CRT ²
		<u>Mean</u>	<u>Rating</u>	<u>Rating</u>	<u>Rating</u>

¹Rated by Dr. L. Panella (3 reps.)

²Rated by Dr. C.R. Trupp and three others, 8-29-95 (2 reps.)

³Checks: US H11 for hybrids; C37 for O.P. lines; C546H3 = C562CMS x C546 for self-fertile lines.

⁴546H3 = C562CMS x C546. 790-15H39 = C762-17CMS x C790-15. 398 = C918.
3911-4 = C911-4. mm,O-T(C) = composite of CTR, O-type, mm lines used as pollinator in composite cross.

TEST 295. BOLTING EVALUATION/SELECTION, SALINAS, CA., 1994-1995

19 entries x 1 replication
1-row plots, up to 1320 ft. long

Planted: November 14, 1994
Ecb inoc.: June 14, 1995
NB selection October 11-12, 1995

Variety	Description	Stand	% Bolting		
		Count No.	06/07	07/20	09/14
<u>MM, O.P. Lines</u>					
R478NB(C78)	NB R278,Y	846	0.5	3.9	4.3
R480NB(C80NB)	NB R280,Y	734	0.5	2.2	2.3
R480-#(C80)	RZM-ER R280-#'s(C)	718	1.8	7.4	8.1
R480-45(C80-45)	RZM-ER R280-34	911	0.0	1.5	1.5
R481-43	RZM R381-43	848	7.8	24.5	29.5
R481-89	RZM R381-89	780	7.9	22.3	24.2
R482NB(C82)	NB R276-43,-89	787	0.8	9.8	11.6
R484	RZM R384	772	2.5	11.4	13.6
<u>MM, S^f, A:aa, Rz Populations</u>					
4911	RZM 3911,(popn-911)	372	4.6	14.8	15.3
4911-4M	3911-4m,Maa x A,(C911-4)	350	0.9	2.3	2.3
4915(Sp)	RZM 3915aa x A	776	5.3	15.9	16.6
4918(Sp)	RZM 3918aa x A,(C918)	1783	3.2	12.1	13.0
<u>MM, S^f, A:aa, Rz Composites</u>					
4909,13,15-#(C)	3909-#'s; 3911-#'s,... ⊗	346	5.2	13.3	13.9
4911-4-#M(C)	3911-4M ⊗	356	0.6	4.2	5.6
4915-#(C)	3915 ⊗	380	3.9	8.2	12.4
4918-#(C)	3918 ⊗	380	1.3	6.8	7.9
<u>mm, S^f, A:aa, Rz Population</u>					
4890m(C890)	RZM 3890mmaa x A	1794	1.9	9.4	11.6
<u>NR-Rz BC₃F₂ Lines</u>					
N457(C608)	NR-RZM N357-#; N358-#(C)	711	3.2	11.4	13.1
N461(C609)	NR-RZM N361-#; N362-#(C)	702	8.1	21.4	24.9

NOTES: Mother roots selected for nonbolting, resistance to Erwinia & rhizomania, beet size and conformation, and % sucrose. Seed was planted into a field plot area with high rhizomania potential; because of winter planting, rhizomania infection was late and mild. Individual plants were inoculated with Erwinia in June. On October 11-12, 1995, roots were selected from the field, based upon NB, no soft rot (Erwinia), size & shape (resistance to rhizomania). In the laboratory, the roots were reselected for sucrose concentration. Seed will be produced in 1996.

TEST 695. BOLTING EVALUATION OF LINES, SALINAS, CA., 1994-1995

120 entries x 3 replications
1-row plots, 22 ft. long

Planted: November 14, 1994
Not harvested for yield

Variety	Description	Beets/ 100	% Bolting		
		No.	06/07	07/20	09/14
MM, O.P.					
SP 7622-0	L80466 (8/87) (SP6822-0)	118	68.6	92.7	97.6
268	Inc. 768 (US 75)	127	0.0	11.0	11.0
U86-37	C37, 86443	126	2.6	8.6	8.6
R470	RZM R370	118	2.7	7.9	9.2
R478NB	NB R278,Y (C78)	123	0.0	7.5	8.6
R478	RZM R378,Y	118	0.0	7.9	9.7
U86-46/2	C46/2, 86342	111	3.2	11.2	13.7
R480NB	NB R280,Y (C80NB)	130	0.0	1.2	2.5
R480-#	RZM-ER R280-#(C) (C80)	123	0.0	6.8	11.9
R480	RZM R380,Y	129	2.4	6.1	10.7
R480-45(Iso)	RZM-ER R280-45 (C80-45)	127	2.3	3.7	7.3
R480-45(Sp)	Inc. R280-45	123	1.1	10.9	15.7
R483	RZM R383(R)	120	3.8	25.6	37.4
Y461	RZM R#(C)	132	11.5	31.8	40.5
Y462	Y#rr(C) x RZM R#(C)	114	2.8	22.6	25.6
Y463	Y#R(C) x RZM R#(C)	121	2.5	21.1	26.1
F86-31/6	C31/6, 86263	115	0.0	14.2	19.4
R476	RZM R376,Y	121	6.3	21.7	28.4
R481-43	RZM R381-43	129	15.3	41.1	50.6
R481-89	RZM R381-89 (C82)	133	17.8	40.4	47.3
R482NB	NB R276-43,-89	121	0.0	12.6	17.6
R484	RZM R384	124	6.0	21.6	26.8
R476-43-#	RZM R376-43-#(C) (C76-43)	126	0.0	2.5	4.9
R476-89-#	RZM R376-89-#(C) (C76-89)	130	2.4	7.2	10.8
R476-43-14	RZM R376-43-14 (C76-43-14)	121	0.0	13.6	14.9
R476-43-15	RZM R376-43-15 (C76-43-15)	130	0.0	3.6	7.0
R476-89-5	RZM R376-89-5 (C76-89-5)	126	3.5	14.2	17.8
R476-89-18	RZM R376-89-18 (C76-89-18)	130	4.7	11.7	11.7
U86-37	C37, 86443	121	0.0	7.3	9.7
R479(Iso)	RZM R379; C79-1(Rz)	120	13.8	37.7	44.4
R424	RZM 3250,P; C79-2 (WB41)	132	5.8	36.8	44.0
R425	RZM 3251,P; C79-3 (WB42)	124	2.6	26.0	34.3
R428	RZM 3202,P; C79-4 (PI07)	118	11.7	34.9	40.2
R428R2	RZM R328	126	3.7	12.1	17.9
R432	RZM 3201,P; C79-5 (R04)	117	1.1	21.2	27.1
R432R2	RZM R332	118	39.7	60.6	69.1
R434	RZM 3245,P; C79-6 (R05)	123	2.5	11.1	16.2
R434R2	RZM R334	120	16.4	64.2	76.9
R435	RZM 3242; C79-7 (SES)	118	15.4	51.7	54.2
R436	RZM 3243,P; C79-8 (R22)	130	8.3	24.4	35.2
R436R2	RZM R336	129	20.8	44.1	51.9
R437	RZM 3247,P; C79-9 (WB151)	127	0.0	9.6	9.6
R437R2	RZM R337	133	14.9	42.3	44.6
R441	RZM 3248,P; C79-10 (WB169)	126	5.6	26.5	32.3
R442	RZM 3249,P; C79-11 (WB258)	112	21.4	49.8	55.2
R443	RZM 3284,5,P (R81-89 x R22)	124	20.0	64.7	66.0
R444	RZM 3287 (2915aa x R22)	117	6.5	35.4	37.9
R479(Sp)	Inc. R379 (C79-1)	111	17.1	34.5	41.3

TEST 695. BOLTING EVALUATION OF LINES, SALINAS, CA., 1994-1995

(cont.)

Variety	Description	Beets/ 100	% Bolting		
		No.	06/07	07/20	09/14
MM, O.P. (cont.)					
U86-37	C37, 86443	120	3.6	12.4	14.5
R422R4(Sp)	RZM R322R4, R4%	130	64.2	87.4	94.3
R422R5	RZM R322R4 (GSY)	127	56.8	83.0	87.5
R422R5%	RZM R322R4 (%)	129	63.3	77.5	85.7
R422Y3 (Iso)	Inc. R322Y3	140	22.0	59.3	59.3
R422Y3% (Iso)	Inc. R322Y3 (%)	127	6.3	38.0	38.0
R422Y3 (Sp)	Inc. R322Y3,Y3%	144	15.8	46.5	53.9
R426	U86-37 x R223 (RZM PI)	132	51.1	68.4	82.9
R440-1	U86-37 x RZM R40 (C)	114	6.1	19.2	22.6
R440-2	RZM R338-1,-2,-3 x RZM R40(C)	132	17.3	46.0	49.5
R409	CR-RZM R209-#(C)	121	3.7	17.1	16.1
R410	CR-RZM R210-#(C)	117	1.3	34.8	37.3
MM, S ^f , A:aa					
P401	PMR P201 (PMR from WB97,242)	127	13.4	42.0	46.7
P402	PMR P202 (PMR from WB97,242)	120	24.0	35.4	43.5
P402NR	NR P202 (NR from WB242)	133	33.3	56.5	63.5
P403	PMR 2211-#(C)	132	8.1	18.6	19.7
P404	PMR 2212-#(C)	127	31.0	54.6	60.1
P405	PMR 2219-#(C)	118	12.6	37.7	44.6
N427	N361aa x 3915,3918	108	5.8	23.9	25.2
N431	NRaa x 3911-4mm	121	1.3	8.9	15.5
N444	NR-RZM N344-#X(C), (BC ₁ F ₄)	126	3.5	11.1	16.0
N444-#	NR_RZM N344, X ⊗	124	6.3	19.5	28.0
N454	NR-RZMN354, (BC ₂ F ₂)	124	11.0	29.4	30.6
N457	NR-RZM N357,8-#(C), (BC ₃ F ₂) (C608)	114	6.6	11.9	20.8
N461	NR-RZM N361-2-#(C), (BC ₃ F ₂) (C609)	123	8.4	28.9	35.3
Z430	RZM Z330	135	1.1	13.3	17.8
4911	RZM 3911	126	1.4	12.0	20.1
4911-4m	3911-4m, mmaa x A (C911-4)	121	2.2	7.8	9.2
4911-4mA	Inc. 3911-4mA (C911-4)	117	1.3	3.9	5.2
4915NB	NB 2915(Sp)	120	0.0	3.9	3.9
4915(Sp)	RZM 3915aa x A	117	13.3	26.2	30.5
4916	RZM 3916	117	3.8	7.8	10.3
4917	RZM 3917	123	1.3	12.9	21.6
4918	RZM 3918aa x A (C918)	118	9.0	20.6	23.2
4913-6	3913-6aa x A	103	4.5	12.0	12.0
4913-9	3913-9aa x A	109	1.2	11.3	12.6
4913-70	RZM 3913-70	129	0.0	1.1	1.1
4913-71	RZM 3913-71	135	3.3	20.0	23.3
4915-6	3915-6aa x A	124	0.0	5.1	6.4
4915-7	3915-7aa x A	123	0.0	6.2	11.1
4915-22	3915-22aa x A	115	0.0	1.5	4.3
4915-34	3915-34aa x A	115	4.1	16.3	19.2

TEST 695. BOLTING EVALUATION OF LINES, SALINAS, CA., 1994-1995

(cont.)

Variety	Description	Beets/	% Bolting		
		100 No.	06/07	07/20	09/14
<u>mm, S^f, A:aa</u>					
U86-37	86443, Inc. C37	102	2.7	17.0	20.6
4831	3911-4m,mmaa x mm,O-T(C) *	127	1.2	4.8	10.9
4832	2915H90,...,2890H15aa x *	117	4.1	18.4	18.4
4833	RZM 3867m(Sp)aa x *	132	15.9	46.6	50.1
4834	RZM 3894m,aa x *	120	8.9	29.3	32.0
4893	RZM 3893, (Rzaa x *)	124	10.3	30.2	33.9
4894	RZM 3894m	132	2.4	20.1	22.4
4895	RZM 3280,...,3282	126	7.2	27.4	34.6
4859m	RZM 3859mmaa x A (C859)	114	18.4	35.2	41.6
4859HO	3859HO x " (C859CMS)	127	18.1	33.3	42.8
4890	RZM 3890mmaa x A (C890)	118	3.9	20.6	25.8
4890HO	3890HO x " (C890CMS)	124	2.7	9.0	14.3
4865NB	NB 2865m(Sp)(%S)(A,aa)	135	8.8	23.9	29.2
4865m	RZM 3865,2866mmaa x A	118	17.7	34.9	38.6
4865HO	2865HO x "	121	4.0	26.0	31.0
4859-2	Inc. 2859mA(Sp)-2	126	9.5	27.1	33.7
4864-8	Inc. 0864-8	121	3.6	11.0	13.4
4864-14	Inc. 0864-14	126	13.0	22.5	28.4
4864-34	Inc. 0864-34	129	10.8	40.6	46.5
4865-4	Inc. 2865mA(Sp)-4	120	32.0	65.7	83.1
4867-1	Inc. 2867mA(Sp)-1	123	12.7	27.9	33.1
4891-4	Inc. 2891mA(Sp)-4	124	0.0	17.0	25.4
<u>mm, S^f lines</u>					
4807	Inc. 9807 (C306)	129	0.0	18.8	27.1
F92-790-15	Inc. C790-15	103	4.0	19.1	30.8
3790-15	Inc. O-type 2790-15-#	109	2.7	12.3	13.8
4790-15	NB F92-790-15	121	1.0	4.8	6.2
4790-15(C)	NB 2790-15-#(C)	102	0.0	2.8	6.9
4790-15-#(C)	Inc. 2790-15-1,-15,-16,-21,-23	126	0.0	1.4	1.4
4790-15-23	Inc. 2790-15-23	96	1.6	6.1	6.1
4790-15-21	Inc. 2790-15-21	80	0.0	0.0	0.0
Mean		122.3	9.4	24.8	29.4
LSD (.05)		18.1	12.3	19.4	19.3
C.V. (%)		9.2	81.1	48.6	40.8
F value		1.8**	9.3**	8.1**	9.6**

* mm,O-T(C) = composite of mm,O-T,CTR lines used as pollinator in composite crosses. Lines included C562, C566, C546, C718, C762-17, etc.

TEST 195. BOLTING EVALUATION OF HYBRIDS, SALINAS, CA., 1994-1995

120 entries x 3 replications
1-row plots, 22 ft. long

Planted: November 14, 1994
Not harvested for yield

Variety ¹	Description ¹	Beets/ 100	% Bolting		
		No.	06/07	07/20	09/14
US H11	L113401, C546H3 x C36	149	0.0	2.0	4.0
WS-PM9	HM-WS-PM9	121	1.0	7.0	9.0
SS-NB3	8/94, Spreckels	111	2.0	2.0	2.0
HM 3013	2010, 9/9/94, Hilleshog-MH	108	1.1	7.1	7.1
2J0179	9/9/94, Betaseed	115	0.0	9.7	13.8
SS-IV3	L94617, 9/7/94, Speckels	126	0.0	11.7	16.3
SS-VY1	L921068, 4/13/93, Speckels	149	14.4	29.3	35.2
Rhizoguard	L892301, 8/30/94, Holly	141	2.1	8.5	12.0
R440H8	F82-546H3 x RZM R40(C)	140	1.2	5.3	6.3
R479H8	F82-546H3 x R379	144	0.0	13.3	14.5
R480-45H8	F82-546H3 x R280-45	132	1.1	2.2	4.3
4918H8	F82-546H3 x RZM 3918	135	0.0	2.3	3.5
R422R4H50	F92-790-15CMS x RZM R322R4, R4%	138	13.2	34.2	40.8
R422R5H50	F92-790-15CMS x RZM R322R4 (GSY)	141	5.4	30.1	41.9
R422R5% ¹ H50	F92-790-15CMS x RZM R322R4 (%)	140	5.5	28.5	33.9
R422Y3H50	F92-790-15CMS x R322Y3	124	3.8	12.5	12.5
R422Y3% ¹ H50	F92-790-15CMS x R322Y3(%)	121	0.0	3.5	6.2
R422Y3H50 (Sp)	F92-790-15CMS x R322Y3, %	129	2.4	22.1	23.3
R428R2H50	F92-790-15CMS x RZM R328	147	0.0	4.2	6.5
R432R2H50	F92-790-15CMS x RZM R332	133	2.5	22.0	29.9
R434R2H50	F92-790-15CMS x RZM R334	132	4.0	4.0	9.0
R436R2H50	F92-790-15CMS x RZM R336	132	1.2	8.1	13.9
R437R2H50	F92-790-15CMS x RZM R337	124	3.5	8.3	8.3
R470H50	F92-790-15CMS x RZM R380	126	0.0	10.7	10.7
R476H50	F92-790-15CMS x RZM R376, Y	146	0.0	2.1	4.3
R476-43-#H50	F92-790-15CMS x RZM R376-43-#(C)	144	0.0	1.0	4.2
R476-43-14H50	F92-790-15CMS x RZM R376-43-14	114	1.2	1.2	1.2
R476-43-15H50	F92-790-15CMS x RZM R376-43-15	129	1.0	2.1	2.1
R476-89-#H50	F92-790-15CMS x RZM R376-89-#(C)	123	2.0	2.0	3.5
R476-89-5H50	F92-790-15CMS x RZM R376-89-5	124	0.0	3.6	8.4
R476-89-18H50	F92-790-15CMS x RZM R376-89-18	144	1.1	6.3	7.3
R478H50	F92-790-15CMS x RZM R378,Y	138	2.0	11.4	11.4
US H11	L113401	144	1.0	2.1	3.2
R440H50	F92-790-15CMS x RZM R40(C)	137	1.1	7.9	10.2
R479H50 (Sp)	F92-790-15CMS x R379	144	1.0	6.1	6.1
R479H50	F92-790-15CMS x RZM R379	117	1.1	12.3	14.6
R480H50	F92-790-15CMS x RZM R380,Y	144	0.0	2.2	5.3
R480-45H50	F92-790-15CMS x R280-45	137	1.0	6.3	11.3
R481-43H50	F92-790-15CMS x RZM R381-43	137	1.1	15.4	26.5
R481-89H50	F92-790-15CMS x RZM R381-89	146	2.9	14.1	16.1
R483H50	F92-790-15CMS x RZM R383	121	3.4	9.2	11.6
R484H50	F92-790-15CMS x RZM R384	123	0.0	1.5	3.5
Z430H50	F92-790-15CMS x RZM Z330	109	0.0	7.3	16.0
4911-4H50	F92-790-15CMS x 3911-4m	130	0.0	1.1	5.8
4913-6H50	F92-790-15CMS x 3913-6	127	0.0	3.5	3.5
4913-9H50	F92-790-15CMS x 3913-9	138	0.0	3.2	6.4
4913-70H50	F92-790-15CMS x RZM 3913-70	129	0.0	1.1	2.2
4913-71H50	F92-790-15CMS x RZM 3913-71	123	1.1	4.9	6.0

TEST 195. BOLTING EVALUATION OF HYBRIDS, SALINAS, CA., 1995

(cont.)

Variety ¹	Description ¹	Beets/ 100	% Bolting		
		No.	06/07	07/20	09/14
4915H50	F92-790-15CMS x RZM 3915	130	2.3	7.0	13.9
4915-6H50	F92-790-15CMS x 3915-6	129	2.0	14.8	19.3
4915-7H50	F92-790-15CMS x 3915-7	120	0.0	6.2	9.9
4915-22H50	F92-790-15CMS x 3915-22	124	2.4	7.1	9.7
4915-34H50	F92-790-15CMS x 3915-34	111	0.0	6.7	10.4
4918H50	F92-790-15CMS x RZM 3918	121	1.3	11.0	14.3
US H11	L113401	147	0.0	3.0	7.1
SS-NB3	8/94, Spreckels	123	0.0	3.7	3.7
R422R4H52	F92-790-15H39 x RZM R322R4, R4%	143	8.8	37.0	37.0
R422Y3H52	F92-790-15H39 x R322Y3, Y3%	144	2.2	22.5	23.6
R440H52	F92-790-15H39 x RZM R40(C)	127	2.5	10.8	14.4
R479H52	F92-790-15H39 x R379	120	4.9	23.5	25.9
R480-45H52	F92-790-15H39 x R280-45	137	0.0	3.2	4.3
4911H52	F92-790-15H39 x RZM 3911	127	2.9	10.5	10.5
4911-4H52	F92-790-15H39 x 3911-4m	124	0.0	2.2	5.6
4913-6H52	F92-790-15H39 x 3913-6	124	3.3	6.4	6.4
4913-9H52	F92-790-15H39 x 3913-9	120	0.0	2.5	5.2
4915-6H52	F92-790-15H39 x 3915-6	129	2.6	9.1	10.4
4915-7H52	F92-790-15H39 x 3915-7	117	2.0	5.1	7.5
4915-22H52	F92-790-15H39 x 3915-22	121	0.0	6.2	9.4
4915-34H52	F92-790-15H39 x 3915-34	109	0.0	6.6	9.6
4916H52	F92-790-15H39 x RZM 3916	124	0.0	0.0	0.0
4917H52	F92-790-15H39 x RZM 3917	124	0.0	18.3	18.3
4918H52	F92-790-15H39 x RZM 3918	130	0.0	7.8	10.0
R440H20	U86-309H3 x RZM R40(C)	138	3.3	11.2	15.9
R480-45H20	U86-309H3 x R280-45	140	2.2	15.8	18.7
R480-45H37	U84-306CMS x R280-45	137	0.0	5.3	5.3
R480-45H30	91-762-17CMS x R280-45	137	5.1	13.6	17.2
R480-45H46	F92-790-6CMS x R280-45	124	2.3	8.9	10.2
R480-45H51	F92-790-15H26 x R280-45	144	3.4	5.4	11.7
R480-45H54	F92-790-54CMS x R280-45	121	3.3	5.6	8.9
4918H37	U84-306CMS x RZM 3918	126	2.2	11.9	11.9
4918H48	F92-790-6H39 x RZM 3918	127	1.3	8.4	10.9
4918H56	F92-790-54H39 x RZM 3918	141	6.3	13.1	13.1
US H11	L113401	133	1.1	10.2	10.2
SS-NB3	8/94, Spreckels	124	0.0	1.1	4.6
R422R4H15	3915aa x RZM R322R4, R4%	132	17.3	48.2	52.8
R422Y3H15	3915aa x R322Y3, Y3%	137	7.9	28.9	35.8
R440H18	3918aa x RZM R40(C)	115	15.7	31.3	35.0
4911-4H25	5816aa x 3911-4m	120	0.0	5.6	5.6
R422R4H17	5747aa x R322R4, R4%	132	15.7	40.9	47.3
R422R4H91	3892m(Sp)aa x RZM R322R4, R4%	144	22.1	47.7	57.1
4918H59- 1	2859mA(Sp)- 1aa x RZM 3918	120	3.6	11.9	18.6
4918H59- 2	2859mA(Sp)- 2aa x RZM 3918	120	4.4	7.8	13.9
4918H59- 7	2859mA(Sp)- 7aa x RZM 3918	120	6.0	21.7	22.9
4918H59- 8	2859mA(Sp)- 8aa x RZM 3918	99	11.9	33.1	38.9
4918H59-10	2859mA(Sp)-10aa x RZM 3918	108	8.2	22.0	23.5
4918H59-14	2859mA(Sp)-14aa x RZM 3918	117	7.8	20.3	23.1

TEST 195. BOLTING EVALUATION OF HYBRIDS, SALINAS, CA., 1995

(cont.)

Variety ¹	Description ¹	Beets/ 100	% Bolting		
		No.	06/07	07/20	09/14
4918H59-21	2859mA(Sp)-21aa x RZM 3918	103	4.4	22.3	22.3
4918H59-23	2859mA(Sp)-23aa x RZM 3918	123	0.0	19.7	24.4
4918H64- 8	3864- 8aa x RZM 3918	137	9.6	35.9	44.4
4918H64-14	3864-14aa x RZM 3918	132	6.3	19.9	27.3
4918H64-34	3864-34aa x RZM 3918	135	2.2	12.0	17.8
4918H65-4	2865mA(Sp)-4aa x RZM 3918	83	13.4	55.9	68.5
4918H65-15	2865mA(Sp)-15aa x RZM 3918	126	1.1	26.8	28.0
4918H65-18	2865mA(Sp)-18aa x RZM 3918	93	0.0	9.5	11.1
4918H65-21	2865mA(Sp)-21aa x RZM 3918	126	1.1	11.9	17.6
4918H67-1	2867mA(Sp)-1aa x RZM 3918	129	2.3	19.1	20.4
4918H67-6	2867mA(Sp)-6aa x RZM 3918	118	1.5	10.5	10.5
4915H93	RZM 3896m,aa x RZM 3915	120	2.5	20.2	22.8
4918H91- 9	2891mA(Sp)- 9 x RZM 3918	126	0.0	5.6	8.8
4918H91-10	2891mA(Sp)-10 x RZM 3918	135	10.1	16.0	17.2
4918H91-16	2891mA(Sp)-16 x RZM 3918	124	4.6	13.9	19.7
4918H91-20	2891mA(Sp)-20 x RZM 3918	132	2.1	22.2	26.5
4918H91-23	2891mA(Sp)-23 x RZM 3918	99	8.3	29.1	30.9
4918H91-27	2891mA(Sp)-27 x RZM 3918	102	3.3	27.8	33.2
4918H91-31	2891mA(Sp)-31 x RZM 3918	135	1.0	4.0	4.0
4918H91-35	2891mA(Sp)-35 x RZM 3918	126	6.0	25.2	30.1
4918H91-42	2891mA(Sp)-42 x RZM 3918	124	2.7	8.5	9.7
4918H8	F82-546H3 x RZM 3918	143	4.4	15.9	15.9
4918H52	F92-790-15H39 x RZM 3918	127	0.0	2.2	3.5
4911-4H90	0790aa x 3911-4m	130	0.0	0.0	1.3
Mean		127.8	3.0	12.6	15.6
LSD (.05)		25.4	6.6	14.5	17.0
C.V. (%)		12.4	137.3	71.7	67.6
F value		1.8**	3.0**	4.6**	4.4**

¹See test 695 for description of component lines. 546H3 = C562CMS x C546.
F82-790-15CMS = C790-15CMS. F92-790-15H39 = C762-17CMS x C790-15. U86-309H3 =
C562CMS x C309. F92-790-15H26 = C309CMS x C790-15. 0790 = C790. 3918 = C918.

TEST 395. BOLTING & ERWINIA EVALUATION IN S₁ PROGENY TEST OF SELFED
MM, S', Aa, Rz LINES & POPULATIONS, SALINAS, CA., 1995

240 entries x 1 replication
1-row plots, 22 ft. long

Planted: November 14, 1994
Ecb inoc.: June 14, 1995
Ecb scored: October 6, 1995

Variety	Description	Beets/ 100' No.	% Bolting			Erwinia	
			06/07	07/20	09/14	DI	%R
			%	%	%	%	%
<u>4915-#'s = 3915(Sp) ♂ (qh 5)</u>							
4915	- 1	100	0.0	4.5	13.6	10.8	85.7
	- 2	114	0.0	0.0	4.0	44.7	53.8
	- 3	146	25.0	43.8	43.8	19.5	77.8
	- 4*	141	0.0	12.9	12.9	6.7	93.3
	- 5*	109	12.5	12.5	12.5	2.2	91.7
	- 6	132	0.0	48.3	48.3	10.5	87.5
	- 7*	109	0.0	0.0	0.0	0.0	100.0
	- 8	96	4.8	19.0	19.0	5.5	85.7
4915	- 9	96	0.0	4.8	9.5	4.7	95.0
	-10*	105	0.0	0.0	0.0	2.5	91.3
	-11	127	10.7	53.6	53.6	0.3	100.0
	-12	105	0.0	0.0	0.0	2.2	95.2
	-13	137	0.0	0.0	0.0	22.4	77.4
	-14	109	12.5	37.5	37.5	9.7	87.5
	-15*	127	0.0	0.0	3.6	7.3	85.2
	-16	118	0.0	0.0	0.0	4.5	95.8
4915	-17*	123	0.0	3.7	3.7	1.0	96.0
	-18*	127	3.6	7.1	7.1	10.9	85.7
	-19	109	0.0	0.0	0.0	28.5	54.5
	-20	127	0.0	0.0	0.0	24.4	64.3
	-21*	100	0.0	0.0	0.0	5.4	91.3
	-22	118	11.5	19.2	26.9	13.1	83.3
	-23	91	5.0	15.0	25.0	24.0	76.5
	-24	114	0.0	0.0	0.0	6.3	83.3
4915	-25	118	0.0	3.8	3.8	87.7	12.0
	-26	109	4.2	25.0	25.0	0.0	100.0
	-27*	123	3.7	11.1	11.1	9.8	87.0
	-28	109	0.0	12.5	12.5	27.5	68.2
	-29*	123	0.0	0.0	0.0	3.3	87.0
	-30	132	3.4	13.8	13.8	15.6	65.2
	-31*	109	0.0	8.3	8.3	1.3	95.7
	-32*	137	0.0	0.0	0.0	1.1	96.7
4915	-33*	114	0.0	4.0	4.0	2.5	95.7
	-34	86	0.0	26.3	26.3	7.1	92.9
	-35	118	0.0	0.0	0.0	50.7	42.9
	-36	127	3.6	14.3	14.3	0.1	100.0
	-37*	118	0.0	3.8	3.8	6.0	92.3
	-38	105	0.0	4.3	4.3	37.8	61.9
	-39	100	0.0	22.7	22.7	23.1	72.2
	-40	9	0.0	0.0	0.0	33.7	66.7
	-41	100	0.0	0.0	0.0	1.3	95.5
<u>4918-#'s = 3918(Sp) ♂ (qh 5)</u>							
4918	- 1*	82	0.0	0.0	0.0	0.0	100.0
	- 2*	118	0.0	0.0	0.0	15.6	81.8
	- 3*	100	0.0	0.0	0.0	1.3	94.7
	- 4*	137	0.0	0.0	0.0	4.2	92.6
	- 5	118	0.0	3.8	3.8	29.0	65.2

TEST 395. BOLTING & ERWINIA EVALUATION IN S₁ PROGENY TEST OF SELFED
MM, S^r, Aa, Rz LINES & POPULATIONS, SALINAS, CA., 1995

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Erwinia	
			06/07	07/20	09/14	DI	%R
		No.	%	%	%	%	%
4918-#'s = 3918(Sp) ♂ (qh 5) (cont.)							
4918	- 6*	114	0.0	0.0	0.0	5.0	87.5
	- 7	27	0.0	0.0	0.0	12.5	75.0
	- 8*	91	0.0	0.0	0.0	22.3	75.0
	- 9*	127	0.0	0.0	0.0	1.1	96.2
	-10*	146	0.0	9.4	9.4	2.9	92.3
	-11	137	0.0	0.0	0.0	4.7	90.3
	-12*	109	0.0	0.0	0.0	0.3	100.0
	-13*	109	0.0	4.2	4.2	5.3	95.0
4918	-14	118	0.0	3.8	7.7	28.6	68.4
	-15	91	0.0	0.0	0.0	19.4	77.8
	-16*	114	0.0	4.0	4.0	8.5	92.3
	-17*	105	0.0	0.0	0.0	8.9	85.7
	-18	132	0.0	0.0	0.0	3.4	88.0
	-19	109	12.5	45.8	45.8	9.3	91.3
	-20	118	3.8	7.7	11.5	20.6	76.0
	-21*	132	0.0	0.0	0.0	1.5	95.8
4918	-22	105	0.0	13.0	13.0	43.7	50.0
	-23*	105	0.0	0.0	0.0	20.5	72.7
	-24	123	0.0	0.0	0.0	0.0	100.0
	-25*	127	0.0	0.0	0.0	6.3	89.3
	-26	132	0.0	0.0	0.0	5.9	94.1
	-27*	137	0.0	6.7	6.7	5.0	93.3
	-28*	114	0.0	0.0	0.0	1.6	95.8
	-29	109	0.0	0.0	0.0	0.0	100.0
4918	-30*	91	0.0	0.0	0.0	19.2	76.5
	-31*	77	0.0	0.0	0.0	8.4	88.9
	-32	100	0.0	0.0	0.0	13.4	87.0
	-33	100	0.0	0.0	0.0	1.8	94.7
	-34*	109	0.0	0.0	0.0	1.4	95.8
	-35	100	0.0	0.0	0.0	0.5	100.0
	-36*	114	0.0	4.0	12.0	0.4	100.0
	-37	114	0.0	0.0	8.0	6.4	83.3
4918	-38	100	0.0	0.0	0.0	0.3	100.0
	-39*	96	0.0	0.0	0.0	7.9	87.0
	-40	118	0.0	0.0	0.0	27.5	68.0
	-41	118	0.0	3.8	3.8	19.7	56.5
	-42	146	0.0	3.1	6.3	8.7	88.5
	-43	132	0.0	13.8	13.8	42.1	55.2
	-44	123	0.0	22.2	22.2	22.3	66.7
	-45	109	0.0	0.0	4.2	30.9	62.1
4918	-46	59	0.0	0.0	0.0	2.2	91.7
	-47	100	0.0	0.0	0.0	3.3	87.0
	-48*	114	0.0	0.0	0.0	7.8	83.3
	-49	82	0.0	0.0	5.6	20.2	78.6
	-50*	114	0.0	8.0	8.0	0.9	96.3
	-51	100	4.5	27.3	27.3	66.7	30.0
	-52	118	0.0	0.0	0.0	0.0	100.0
	-53	114	0.0	0.0	0.0	4.7	92.6

TEST 395. BOLTING & ERWINIA EVALUATION IN S₁ PROGENY TEST OF SELFED
MM, S', Aa, Rz LINES & POPULATIONS, SALINAS, CA., 1995

(cont.)

Variety	Description	Beets/ 100' No.	% Bolting			Erwinia	
			06/07	07/20	09/14	DI	%R
			%	%	%	%	%
<u>4918-#'s = 3918(Sp) × (qh 5) (cont.)</u>							
4918	-54	100	0.0	4.5	4.5	0.1	100.0
	-55	91	0.0	0.0	0.0	4.9	86.4
	-56	100	0.0	0.0	0.0	0.0	100.0
	-57	64	0.0	21.4	21.4	4.3	91.7
	-58	123	7.4	22.2	22.2	0.3	100.0
	-59	96	0.0	0.0	0.0	14.2	83.3
	-60	105	0.0	4.3	17.4	13.4	72.7
	-61	118	3.8	34.6	38.5	18.2	81.8
	-62	118	0.0	0.0	0.0	0.1	100.0
<u>4911-4-#'sM = 3911-4M × (qh 4)</u>							
4911-4	- 1M*	96	0.0	0.0	0.0	1.2	95.5
	- 2*	91	0.0	0.0	0.0	0.4	100.0
	- 3	105	0.0	0.0	0.0	1.4	94.4
	- 4*	109	0.0	0.0	0.0	11.5	85.7
	- 5	123	0.0	3.7	3.7	1.4	96.0
	- 6*	118	0.0	0.0	0.0	6.8	88.5
	- 7*	132	0.0	0.0	0.0	0.0	100.0
	- 8*	118	0.0	0.0	0.0	15.6	62.5
4911-4	- 9M*	109	0.0	0.0	0.0	3.6	95.7
	-10*	109	0.0	0.0	0.0	14.4	85.7
	-11	105	4.3	8.7	8.7	3.8	85.2
	-12	132	0.0	0.0	0.0	1.0	96.4
	-13*	114	4.0	8.0	8.0	18.6	81.5
	-14	5	0.0	0.0	0.0	75.0	0.0
	-15	0	0.0	0.0	0.0	0.0	0.0
	-16*	105	0.0	0.0	0.0	8.8	75.0
4911-4	-17M*	73	0.0	0.0	0.0	0.0	100.0
	-18	0	0.0	0.0	0.0	0.0	0.0
	-19	100	0.0	0.0	0.0	1.2	95.2
	-20	114	0.0	0.0	0.0	23.8	52.4
	-21*	91	0.0	5.0	5.0	8.3	81.0
	-22	91	0.0	0.0	5.0	3.2	90.0
	-23	0	0.0	0.0	0.0	0.0	0.0
	-24*	105	0.0	0.0	0.0	1.1	95.7
4911-4	-25M	91	0.0	0.0	0.0	0.1	100.0
	-26	100	0.0	0.0	0.0	37.2	55.6
	-27*	118	0.0	0.0	0.0	19.6	78.3
	-28*	141	0.0	0.0	0.0	2.0	92.3
	-29	77	0.0	0.0	0.0	4.5	82.4
	-30	73	0.0	0.0	0.0	25.0	58.3
	-31	100	0.0	0.0	4.5	26.9	66.7
	-32	23	0.0	0.0	0.0	8.3	66.7
4911-4	-33M	50	0.0	0.0	0.0	0.1	100.0
	-34	50	0.0	0.0	0.0	0.6	100.0
	-35	27	0.0	0.0	0.0	0.0	100.0
	-36*	109	0.0	12.5	12.5	2.0	95.2
	-37	91	0.0	0.0	0.0	5.0	95.0
	-38	59	0.0	0.0	0.0	29.0	62.5

TEST 395. BOLTING EVALUATION AND S₁ PROGENY TEST OF SELFED
MM, S^f, Aa, Rz LINES & POPULATIONS, SALINAS, CA., 1995

(cont.)

Variety	Description	Beets/ 100' No.	% Bolting			Erwinia	
			06/07	07/20	09/14	DI	%R
			%	%	%	%	%
<u>4911-4-#'sM = 3911-4M Ⓢ (qh 4)</u>							
4911-4	-39M*	132	0.0	0.0	0.0	0.0	100.0
	-40	0	0.0	0.0	0.0	0.0	0.0
	-41	55	0.0	0.0	0.0	4.6	81.8
	-42	86	0.0	0.0	0.0	44.5	50.0
	-43	23	0.0	0.0	0.0	31.3	50.0
	-44	109	0.0	0.0	0.0	6.3	90.0
	-45	73	0.0	0.0	0.0	0.0	100.0
	-46	5	0.0	0.0	0.0	0.0	100.0
4911-4	-47M	105	0.0	0.0	0.0	6.5	94.1
	-48	0	0.0	0.0	0.0	0.0	0.0
	-49	0	0.0	0.0	0.0	0.0	0.0
	-50	91	0.0	0.0	0.0	1.0	100.0
<u>4909-34/37-#'s = 3909-34,-37 Ⓢ (qh 5)</u>							
4909-34/37	-1	114	0.0	4.0	4.0	8.0	90.9
	-2	100	0.0	36.4	50.0	5.7	94.7
	-3	0	0.0	0.0	0.0	0.0	0.0
	-4	27	0.0	16.7	16.7	23.3	75.0
<u>4911-12-# = 3911-12 Ⓢ (qh 5)</u>							
4911-12-1*		150	0.0	0.0	0.0	15.6	77.4
<u>4911-14-#'s = 3911-14 Ⓢ (qh 5)</u>							
4911-14	- 1	123	0.0	0.0	0.0	30.5	69.2
	- 2*	123	0.0	3.7	3.7	0.0	100.0
	- 3	100	0.0	9.1	9.1	33.3	66.7
	- 4	118	0.0	11.5	11.5	31.3	66.7
	- 5	155	5.9	20.6	23.5	0.0	100.0
	- 6*	123	0.0	0.0	3.7	1.9	96.2
	- 7	109	0.0	0.0	0.0	33.8	59.1
	- 8	91	0.0	0.0	0.0	3.4	93.3
4911-14	- 9	82	0.0	0.0	0.0	4.7	95.0
	-10	109	4.2	16.7	16.7	6.3	87.5
	-11	100	0.0	4.5	4.5	11.4	86.4
	-12	86	0.0	0.0	10.5	5.1	90.0
	-13	96	0.0	0.0	0.0	50.6	44.4
	-14	105	0.0	17.4	26.1	28.2	64.7
	-15	105	4.3	13.0	13.0	15.8	84.6
	-16	127	0.0	7.1	7.1	4.8	90.5
4911-14	-17	100	0.0	27.3	27.3	1.6	95.0
	-18	77	0.0	11.8	11.8	10.2	78.6
	-19	109	8.3	29.2	29.2	0.0	100.0
	-20	127	0.0	17.9	25.0	0.0	100.0

TEST 395. BOLTING & ERWINIA EVALUATION IN S₁ PROGENY TEST OF SELFED
MM, S^r, Aa, Rz LINES & POPULATIONS, SALINAS, CA., 1995

(cont.)

Variety	Description	Beets/ 100' No.	% Bolting			Erwinia	
			06/07 %	07/20 %	09/14 %	DI %	%R %
<u>4911-50-#'s = 3911-50 ♂ (qh 5)</u>							
4911-50	- 1*	137	0.0	3.3	3.3	1.9	96.3
	- 2	123	0.0	0.0	22.2	25.4	69.2
	- 3	109	0.0	8.3	8.3	37.5	59.1
	- 4	127	3.6	50.0	50.0	52.7	37.9
	- 5*	64	0.0	0.0	0.0	7.2	92.9
	- 6	123	0.0	3.7	3.7	23.9	67.9
	- 7	114	0.0	28.0	28.0	4.5	88.0
	- 8	0	0.0	0.0	0.0	0.0	0.0
	- 9	105	21.7	52.2	52.2	10.6	90.5
<u>4913-6-#'s = 3913-6 ♂</u>							
4913-6	- 1	100	0.0	9.1	9.1	8.0	87.0
	- 2	73	0.0	6.3	6.3	3.9	90.5
	- 3	86	0.0	0.0	15.8	24.1	55.6
	- 4	68	0.0	6.7	6.7	17.1	80.0
	- 5	23	0.0	0.0	0.0	0.0	100.0
	- 6	14	0.0	0.0	0.0	0.0	100.0
	- 7	127	0.0	7.1	10.7	27.4	53.8
<u>4913-9-#'s = 3913-9 ♂</u>							
4913-9	- 1	132	0.0	0.0	0.0	18.5	69.0
	- 2	105	0.0	0.0	0.0	14.4	80.0
	- 3	109	0.0	0.0	0.0	45.3	37.5
	- 4	9	0.0	0.0	0.0	50.0	0.0
	- 5	82	0.0	11.1	22.2	12.2	82.4
	- 6	27	0.0	33.3	33.3	40.2	40.0
	- 7	0	0.0	0.0	0.0	37.5	50.0
	- 8	0	0.0	0.0	0.0	0.0	0.0
	- 9	9	0.0	50.0	100.0	0.0	0.0
	-10	0	0.0	0.0	0.0	0.0	0.0
<u>4915-6-#'s = 3915-6 ♂</u>							
4915-6	- 1*	123	0.0	3.7	3.7	9.3	88.0
	- 2*	0	0.0	0.0	0.0	0.0	0.0
	- 3	127	0.0	0.0	0.0	5.2	88.9
	- 4	109	0.0	0.0	0.0	2.5	91.3
	- 5	73	0.0	0.0	0.0	7.9	81.3
	- 6	114	0.0	12.0	20.0	29.8	45.5
	- 7	127	3.6	10.7	10.7	0.0	100.0
	- 8	137	0.0	3.3	10.0	6.3	84.0
<u>4915-7-#'s = 3915-7 ♂</u>							
4915-7	- 1	114	0.0	4.0	16.0	12.5	66.7
	- 2	109	0.0	4.2	4.2	37.0	45.0
	- 3*	105	0.0	4.3	4.3	12.2	81.8

TEST 395. BOLTING & ERWINIA EVALUATION IN S₁ PROGENY TEST OF SELFED
MM, S^f, Aa, Rz LINES & POPULATIONS, SALINAS, CA., 1995

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Erwinia	
		No.	06/07	07/20	09/14	DI	%H
			<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>
<u>4915-7-#'s = 3915-7 ♂ (cont.)</u>							
4915-7	- 4	109	0.0	8.3	8.3	32.3	50.0
	- 5	109	0.0	4.2	4.2	4.7	82.6
	- 6*	100	0.0	0.0	0.0	2.6	90.0
	- 7	114	0.0	12.0	16.0	21.5	62.5
	- 8	82	0.0	5.6	5.6	13.8	64.7
	- 9	118	0.0	0.0	0.0	6.6	84.6
	-10	0	0.0	0.0	0.0	0.0	0.0
<u>4915-22-#'s = 3915-22 ♂</u>							
4915-22	- 1	114	0.0	0.0	0.0	22.3	62.5
	- 2	118	0.0	19.2	19.2	13.4	80.0
	- 3	100	0.0	36.4	40.9	4.7	91.3
	- 4	109	0.0	29.2	29.2	6.9	85.7
	- 5	96	0.0	0.0	0.0	46.5	33.3
	- 6	146	0.0	6.3	6.3	30.8	53.6
4915-22	- 7	105	0.0	0.0	8.7	34.9	47.6
	- 8	14	0.0	0.0	33.3	75.0	0.0
	- 9	18	0.0	25.0	50.0	39.3	50.0
	-10	0	0.0	0.0	0.0	0.0	0.0
	-11	41	0.0	11.1	11.1	0.8	100.0
	-12	23	0.0	60.0	60.0	44.0	33.3
<u>4915-34-#'s = 3915-34 ♂</u>							
4915-34	- 1*	118	0.0	0.0	7.7	9.9	82.6
	- 2	123	0.0	51.9	51.9	0.7	100.0
	- 3	0	0.0	0.0	0.0	0.0	0.0
	- 4	77	5.9	23.5	58.8	0.5	100.0
	- 5	59	0.0	7.7	7.7	0.0	100.0
<u>4915-#(C) = 3915(Sp) ♂</u>							
4915-#(C)		118	3.8	19.2	26.9	36.8	50.0

NOTES: 4915-#'s, 4918-#'s, 4911-4-#, et al. were from selfed (Aa) plants under paper bags in the greenhouse. S₁ seed was planted in tests 395 and 5395 (evaluation for rhizomania). Based upon these two progeny tests, Rz roots from within the best progeny lines in test 5395 were selected and stored in cold room. The best of these will be increased/recombined in 1996. Because of the small amount of seed from greenhouse selfs, not as many lines were planted in test 5395. Selected lines (plants) will be known to be self-fertile and most will segregate for genetic ms (A₋:aa).

* S₁ lines from which mother roots were selected from test 5395.

TEST 5395. S₁ PROGENY TEST FOR RHIZOMANIA OF LINES FROM Sf,MM,A:aa,Rz POPULATIONS & LINES,
SALINAS, CA., 1995

128 entries x 1 replication
1-row plots, 20 ft. long

Planted: May 4, 1995
Harvested: November 7-8, 1995

Code	Variety	Acre Yield		Beets/ 100'	RJAP %	Powdery Mildew Score ¹	RZM Resistance ²	
		Sugar Lbs	Beets Tons				Sucrose %	No.
<u>4915-#'s = 3915(Sp) @ (gh 5)</u>								
1	4915- 1	6182	20.54	140	75.6	2.5	3.4	83.3
2	- 2	7592	24.97	155	79.4	1.5	3.0	87.9
3	- 3	6856	22.41	155	78.5	2.0	2.8	96.2
4	- 4*	8132	31.28	150	79.0	2.0	3.4	78.6
5	- 5*	10713	37.59	140	81.9	1.5	2.7	100.0
6	- 6	7685	26.14	175	78.0	1.0	3.2	88.9
7	- 7*	7260	25.21	150	81.1	1.5	3.1	96.3
8	- 9	5130	17.27	155	80.1	2.0	4.3	40.0
9	-10*	8159	30.11	150	75.9	1.5	3.2	92.3
10	-14	7872	28.94	145	76.4	2.5	2.9	100.0
11	4915-15*	7991	25.21	145	78.5	1.5	2.9	100.0
12	-17*	8514	29.88	145	79.8	1.0	3.4	72.4
13	-18*	8860	30.34	160	75.6	1.5	2.9	96.7
14	-19	9547	35.62	90	76.8	1.5	2.7	100.0
15	-20	7525	24.04	150	78.6	1.5	2.9	100.0
16	-21*	7051	24.74	165	77.7	2.5	3.2	92.6
17	-22	8984	32.91	210	77.8	2.5	3.2	90.6
18	-23	9312	33.38	165	76.6	1.5	2.6	100.0
19	-26	7184	22.17	120	78.5	1.5	2.9	100.0
20	-27*	10146	32.21	145	77.2	2.0	3.1	96.3
21	4915-28	8385	26.53	170	77.1	2.0	3.1	90.0
22	-29*	7525	24.04	160	76.0	1.0	3.1	96.8
23	-30	6448	19.84	160	76.3	2.5	3.0	100.0
24	-31*	5980	19.61	170	78.6	2.0	3.3	81.8
25	-32*	9215	32.68	145	81.7	3.0	3.1	93.8
26	-33*	10130	32.68	155	78.3	2.5	3.0	100.0
27	-34	8226	29.48	120	78.2	2.0	3.0	100.0
28	-35	9073	29.18	155	76.6	1.5	3.2	90.3
29	-37*	9646	33.61	160	78.6	1.5	3.1	95.8

TEST 5395. S₁ PROGENY TEST FOR RHIZOMANIA OF LINES FROM Sf,MM,A:aa,Rz POPULATIONS & LINES,
SALINAS, CA., 1995

(cont.)

Code	Variety	Acre Yield		Sucrose %	Beets/ 100'	RJAP %	Powdery Mildew Score ¹	RZM Resistance ²	
		Sugar Lbs	Beets Tons					DI	%R
4918-#'s = 3918(Sp) ♂ (qh 5)									
30	4918- 1*	8366	27.07	15.4	170	77.4	1.0	3.3	87.5
31	- 2*	8133	28.94	14.0	155	82.9	2.0	3.3	89.7
32	- 3*	9006	27.54	16.4	170	75.5	2.0	3.2	88.2
33	- 4*	8262	27.54	15.0	130	81.1	2.5	3.3	85.7
34	- 5	10616	38.74	13.7	150	75.9	1.0	2.9	100.0
35	- 6*	7658	25.44	15.1	150	80.9	2.0	3.1	89.3
36	-36*	8321	26.84	15.5	145	80.9	2.0	4.2	44.0
37	- 8*	12329	40.29	15.3	160	79.5	2.0	3.1	93.5
38	- 9*	7492	23.34	16.0	145	76.1	2.0	3.1	93.3
39	-10*	9540	29.18	16.4	150	78.0	1.5	3.6	73.3
40	4918-11	5910	19.90	14.9	140	74.1	4.5	3.6	74.1
41	-12*	9617	29.41	16.4	155	77.5	2.0	3.2	93.1
42	-13*	9579	33.38	14.4	150	78.8	1.5	3.4	78.1
43	-14	7530	26.61	14.1	170	75.7	1.5	3.2	82.4
44	-15	4668	13.73	17.0	170	76.7	2.5	4.4	33.3
45	-16*	9950	33.84	14.7	175	78.4	1.5	2.9	96.9
46	-17*	5565	18.43	15.1	135	73.1	2.0	3.3	87.0
47	-18	4882	14.70	16.6	155	78.9	3.0	3.4	79.4
48	-19	7450	24.51	15.2	140	74.0	2.0	3.2	88.0
49	-20	7018	22.64	15.5	150	78.5	1.5	4.0	50.0
50	4918-21*	10290	32.16	16.0	180	81.8	1.5	2.8	97.2
51	-22	8798	28.94	15.2	150	80.9	1.0	3.4	78.1
52	-23*	9273	31.98	14.5	145	77.3	2.0	3.3	83.3
53	-24	6894	25.44	13.5	170	71.9	1.5	3.6	70.0
54	-25*	9570	30.58	15.6	140	78.3	2.0	3.1	93.1
55	-26	7452	24.04	15.5	130	76.7	1.5	3.4	77.8
56	-27*	9680	29.88	16.2	175	77.5	2.0	3.5	77.1
57	-28*	7713	25.21	15.3	140	75.0	2.0	2.9	100.0
58	-29	9426	29.64	15.9	130	78.7	2.5	3.3	91.3
59	-30*	9244	32.21	14.4	160	77.8	1.5	3.3	83.3

TEST 5395. S₁ PROGENY TEST FOR RHIZOMANIA OF LINES FROM Sf,MM,A:aa,Rz POPULATIONS & LINES,
SALINAS, CA., 1995

(cont.)

Code	Variety	Acre Yield		Beets/ 100'	RJAP %	Powdery Mildew		RZM Resistance ²	
		Sugar Lbs	Beets Tons			Sucrose %	No.	Score ¹	DI
4918-#'s = 3918(Sp) ♂ (gh 5) (cont.)									
60	4918-31* -32 -33 -34* -39* -40 -41 -42 -43 -44	9381	29.41	140	74.7	2.0	3.4	80.0	
61		8541	24.97	130	78.4	2.5	3.1	100.0	
62		5347	16.10	130	71.2	2.0	3.2	92.9	
63		7638	23.57	205	74.8	1.5	3.3	87.8	
64		7963	27.27	175	76.8	1.5	3.4	79.4	
65		8757	26.14	140	77.2	1.5	3.1	96.7	
66		7803	23.57	155	78.3	2.5	3.4	83.3	
67		6742	21.47	165	78.3	2.0	3.9	57.6	
68		7867	24.97	125	80.2	2.0	3.5	81.8	
69		7579	23.11	130	76.6	3.0	3.5	76.9	
70	4918-45 -46 -48* -50* -51 -52	4751	16.10	175	81.5	2.5	4.6	30.0	
71		4991	18.91	165	75.2	1.0	4.4	31.3	
72		9364	30.11	145	75.9	2.0	2.9	100.0	
73		9426	29.64	160	77.8	2.0	3.2	90.3	
74		6132	20.31	145	75.7	1.0	3.3	89.3	
75		6158	18.44	150	79.1	1.5	4.0	50.0	
4911-4-#'sM = 3911-4M ♂ (gh 4)									
76	4911-4 - 1M* - 2* - 3 - 4* - 5 - 6* - 8* -10* - 7* -16* 4911-4 -17* - 9* -21* -24*	10450	34.15	170	77.9	3.0	3.5	78.8	
77		9604	29.64	155	75.2	1.5	3.0	97.1	
78		8832	27.77	145	77.4	1.5	3.1	96.3	
79		7564	24.32	150	78.1	1.5	3.1	96.7	
80		7584	22.64	140	76.7	2.0	3.1	96.6	
81		9808	31.74	150	78.0	2.0	3.5	75.9	
82		7855	26.36	120	76.4	1.5	3.6	76.0	
83		8779	25.16	160	77.0	2.0	3.5	90.0	
84		8924	28.24	150	74.0	1.5	3.3	87.5	
85		9047	31.74	150	75.2	2.0	3.3	87.5	
86		8813	28.71	135	76.0	2.0	3.1	100.0	
87		6885	23.34	110	80.6	3.0	3.7	70.8	
88		8852	29.41	140	79.4	2.0	3.1	100.0	
89		8116	25.44	130	75.1	1.0	3.3	88.5	

TEST 5395. S₁ PROGENY TEST FOR RHIZOMANIA OF LINES FROM Sf,MM,A:aa,Rz POPULATIONS & LINES,
SALINAS, CA., 1995

(cont.)

Code	Variety	Acre Yield		Sucrose %	Beets/ 100' No.	RJAP %	Powdery Mildew Score ¹	RZM Resistance ²	
		Sugar Lbs	Beets Tons					DI	%R
<u>4911-4-#sM = 3911-4M & (gh 4) (cont.)</u>									
90	4911-4 -27*	6634	21.13	15.7	140	75.3	1.0	3.3	91.7
91	-28*	9478	30.58	15.5	140	79.1	1.0	3.2	88.9
92	-30	9022	29.88	15.1	130	80.1	1.5	3.0	100.0
93	-31	6124	19.14	16.0	165	76.2	2.5	3.3	96.2
94	-13*	8185	24.51	16.7	145	75.6	1.5	3.3	90.3
95	-20	7702	23.34	16.5	105	79.1	1.5	3.6	76.5
96	-36*	10501	34.54	15.2	150	79.0	1.0	3.4	82.8
97	-39*	10041	32.92	15.3	135	76.4	3.0	3.3	88.9
<u>4909-34/37-#s = 399-34,-37 & (gh 5)</u>									
98	4909-34/37-1	6733	21.24	15.8	140	79.4	3.0	3.1	88.0
99	4909-34/37-2	3594	11.67	15.4	170	80.6	3.0	4.1	47.1
<u>4911-12-# = 3911-12 & (gh 5)</u>									
100	4911-12-1*	9662	30.58	15.8	155	73.7	1.5	3.2	96.2
<u>4911-14-#s = 3911-14 & (gh 5)</u>									
101	4911-14 - 1	7339	22.17	16.5	165	77.9	3.0	3.2	93.5
102	- 2*	6624	19.65	16.8	135	78.2	2.5	3.7	77.8
103	- 3	4448	13.77	16.1	140	75.6	3.0	3.4	84.2
104	- 4	6655	20.54	16.2	125	77.3	2.0	3.5	76.2
105	- 5	6839	21.24	16.1	170	77.8	2.0	3.6	76.9
106	- 6*	6507	19.84	16.4	150	75.8	2.5	3.4	84.0
107	- 7	5082	15.64	16.3	150	80.8	1.5	3.5	75.0
108	-11	6485	18.91	17.2	145	80.5	2.5	3.3	85.7
109	-20	6283	20.07	15.6	165	76.2	1.0	3.3	90.3

TEST 5395. S₁ PROGENY TEST FOR RHIZOMANIA OF LINES FROM Sf,MM,A:aa,Rz POPULATIONS & LINES,
SALINAS, CA., 1995

(cont.)

Code	Variety	Acre Yield		Beets/ 100'	RJAP %	Powdery Mildew Score ¹	RZM Resistance ²	
		Sugar Lbs	Beets Tons				Sucrose %	DI
<u>4911-50-#'s = 3911-50 ♂ (qh 5)</u>								
110	4911-50	7915	25.21	165	79.7	1.0	3.6	71.0
111	- 2	7891	24.51	150	77.6	1.5	4.1	62.5
112	- 3	8856	28.94	155	78.7	1.5	3.5	70.0
113	- 4	9495	28.01	150	77.2	2.0	3.6	78.8
114	- 5*	7937	25.44	160	82.3	2.0	4.0	59.4
<u>4913-6-#'s = 3913-6 ♂ (qh 5)</u>								
115	4913-6- 1	6031	17.74	145	80.2	2.0	3.7	67.9
<u>4913-9-#'s = 3913-9 ♂ (qh 5)</u>								
116	4913-9- 1	5113	15.17	170	81.4	2.5	5.2	15.2
117	- 2	4117	13.07	120	78.8	1.5	4.0	53.8
<u>4915-6-#'s = 3915-6 ♂ (qh 5)</u>								
118	4915-6- 1*	8691	24.97	140	80.4	2.5	3.1	96.2
119	- 2*	7571	23.81	145	76.3	1.0	2.9	100.0
120	- 6	6791	18.92	160	80.3	1.0	3.0	100.0
<u>4915-7-#'s = 3915-7 ♂ (qh 5)</u>								
121	4915-7 - 1	6884	19.84	170	78.9	2.5	3.4	83.9
122	- 2	5130	16.34	145	76.0	1.5	3.5	77.8
123	- 3*	7361	22.17	180	79.0	1.5	3.9	64.7
124	- 6*	5588	16.34	150	82.2	1.5	3.7	73.1

TEST 5395. S₁ PROGENY TEST FOR RHIZOMANIA OF LINES FROM Sf,MM,A:aa,Rz POPULATIONS & LINES,
SALINAS, CA., 1995

(cont.)

Code	Variety	Acre Yield		Sugar Lbs	Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Powdery Mildew		RZM Resistance ²	
		Sugar Lbs	Beets Tons						Score ¹	DI	%R	
<u>4915-22-#'s = 3915-22 ♂ (qh 5)</u>												
125	4915-22- 1	7982	23.34			17.1	125	77.6	1.0		3.5	80.8
126	- 2	5040	15.65			16.1	90	80.9	1.0		3.1	81.3
<u>4915-34-#'s = 3915-34 ♂ (qh 5)</u>												
127	4915-34- 1*	7681	24.08			16.0	125	79.9	2.5		3.6	76.0
128	- 2	7916	24.51			16.1	160	76.9	1.5		3.7	67.7

NOTES: 4915-#'s, 4918-#'s, 4911-4-#'s, et al. are S₁ lines produced by selfing Aa plants under paper bags in the greenhouse. S₁ seed was planted in tests 5395 and 395 (bolting and Erwinia evaluations). Based upon these two progeny tests, Rz roots from within the best progeny lines in test 5395 were selected and stored in cold room. The best of these will be increased/recombined in 1996. Only S₁ lines with enough seed and known to be self-fertile were planted in 5395. For lines from which mother roots were selected, all roots were weighed for root yield but only the unselected roots were run through the sugar lab.

¹Powdery mildew was scored late after the effects of Bayleton had worn off on a scale of 0 to 9, where 9 = highly susceptible.

²Rhizomania was scored on an individual beet basis where 0 = highly resistant and 9 = highly susceptible. Resistance was considered scores of 0 through 4. Effects of rhizomania were only moderate.

* S₁ lines from which mother roots were selected on the basis of information from tests 395 and 5395. Population 4918 was released as C918 and 3911-4 as C911-4. These tests give some indication of the range of variability within these two populations.

Project #280: Improved Soil Test for BNYVV using Molecular and Immunological Probes

G. C. Wisler, J. E. Duffus, and H.-Y. Liu

The importance of the Rhizomania disease of sugarbeets warrants a sensitive, highly specific detection technique which is capable of processing large numbers of samples. The most popular technique for diagnosis of BNYVV, the causal agent of Rhizomania, is ELISA. However, the ELISA technique is subject to misdiagnosis of BNYVV due to serological relationships and cross-reactions observed between BNYVV and isolates which are serologically related to the beet soil borne mosaic virus (BSBMV; originally called Texas-7 and-8). The primary objective of this study is to develop a technique for diagnosis of BNYVV which is not hampered by interrelationships between BNYVV and related furoviruses, and which can ultimately detect viruliferous cystosori in fallow soil. To accomplish this goal, comparisons must be made between available techniques for their sensitivity and specificity.

Generally, the more sensitive a diagnostic technique is, the more likely it is to show cross-reactivity with related organisms. This is the case with both ELISA and western blot analyses. However, in ELISA, the distinction cannot be made between a low homologous reading and a reaction of relatedness from a different organism. In Western blots, these distinctions can be made due to the qualitative nature of this test. For example, since the molecular weight of BNYVV capsid protein is different from that of BSBMV related isolates, cross-reactivities can be easily determined, providing the appropriate controls are included. Tests at the USDA in Salinas, CA using monoclonal antisera to the capsid protein of BNYVV and to the 3'-terminal portion of the cloned capsid protein are completely specific to BNYVV, with no cross-reactivity with BSBMV isolates. The one drawback to the use of western blots for routine diagnosis is that it is not well suited for large numbers of samples. However, for best diagnosis to date, this appears to be the method of choice. Another serological test, immunodiffusion, is specific for BNYVV, also providing qualitative information, however this technique uses large amounts of antiserum, and is therefore not practical.

The comparative sensitivities of western blot analysis, ELISA, biological assay on indicator plants, and dot-blot hybridization were compared for detection of BNYVV infected sugarbeet seedlings. Sugarbeet seedlings were inoculated with either BNYVV-infected *Polymyxa betae*, *P. betae* alone, or were treated with water only. Each treatment was inoculated at ten-fold serial dilutions up to one part in one million. After six weeks growth in the greenhouse, roots were washed, examined for the presence of *P. betae* cystosori, and tested by the techniques listed. Cystosori were observed up to a dilution of 1/1000 from *P. betae* inoculated seedlings, after which no cysts were observed. ELISA, western blots and dot blots detected BNYVV in inoculated plants at a 1/1000 dilution as well.

In another test, BNYVV-infected seedlings were subjected to two-fold serial dilutions and tested in the techniques listed for comparative sensitivities. The detection limit for ELISA was 1/1028 using 150-200 microliters of sample, whereas the limit for western blots was 1/2048 using 5-7 microliters of sample. The limit for dot-blot was comparable to that of ELISA with a detection limit of 1/1024 using 1-2 microliters per sample.

Another important aspect of detection of BNYVV using molecular probes is the interrelationship of each RNA from BNYVV with those of other related furoviruses. The results of this study are shown in the Figure. All of the BNYVV probes to RNA 1, 2, and 3 reacted with the three BNYVV isolates tested, and with three of four of the BSBMV-related isolates tested. Probes made to the RNA 1, 2, and 3 of BSBMV-2 did not react with the three BNYVV isolates, and reacted differentially with the four isolates which are serologically identical to BSBMV-1 and -2.

Results from these studies are preliminary and will be repeated. To date, no technique tested is sensitive enough to detect one viruliferous cyst of *P. betae*. However, there are techniques available now which can accurately distinguish BNYVV from related furoviruses of sugarbeet. Currently, the most sensitive and specific method is western blot analyses using polyclonal antisera to BNYVV, BSBMV, and/or monoclonal antibodies to the BNYVV capsid protein. Although all of these antisera are not available commercially, they can be obtained from collaborators in the field of study. The dot-blot hybridization technique using nonradioactive probes is promising for the sensitivity, but other regions of the genome must be explored which are more specific than those tested. Additional techniques including "nested-PCR" are now available which may provide both the sensitivity and specificity required for accurate diagnosis of Rhizomania-infected soil. These techniques will be evaluated with respect to the goals of this project.

Detection of BNYVV and BSBMV-related isolates by dot-blot hybridization

Isolates	BNYVV RNA probes				BSBMV RNA probes			neg ck
	R 1	R 2	R 3	R 4	R 1	R 2	R 3	-
BNYVV CA	+	+	+	-	-	-	-	-
BNYVV NE	+	+	+	+	-	-	-	-
BNYVV CO	+	+	+	+	-	-	+	-
BSBMV 1	+	+	+	+/-	+	+	+	-
BSBMV 2	+	+	+	+	-	+	+	-
NE 10	+	+	+	+/-	+	+	+	-
NE 1644	-	-	-	-	-	+/-	-	-
healthy	-	-	-	-	-	-	-	-

Evaluation of Photosynthetic Parameters in the Selection of Varieties with Improved Rates of Sugar Production

Project 250

Professor Norman Terry, University of California, Berkeley, CA

During the 1993 growing season, we sought to optimize the experimental procedure for using pulse-modulated fluorescence to develop new high-yielding genotypes. Our objectives were to: 1) increase the size of the selection sample as well as that of the total population screened, 2) to provide growing conditions which minimized competition between plants for light and nutrients, and 3) to increase the length of time between fluorescence measurement and harvesting (particularly for root sugar content).

The 1993 greenhouse experiment permitted us to increase the sample size at the time of selection and the total size of population screened, and to increase illumination and mineral nutrient supply. However, we also encountered unanticipated setbacks in that plants wilted after transfer from the growth chamber to the greenhouse, suffered damage following an unusual heat wave, and some plants developed fungal infections of their roots. The faster-growing plants were more prone to damage than their slow-growing counterparts and we believe that this, along with increased variability, reduced our chances of obtaining good correlations of sugar yield with fluorescence.

During the past year we continued to carry out the experiments inside a computer-controlled greenhouse which maintains temperatures and irradiance within certain defined limits. This facility enabled us to grow the plants in a single controlled environment and to illuminate the plants at high light intensities (up to $2000 \mu\text{mol m}^{-2} \text{s}^{-1}$). In 1994's experiment we avoided the difficulties we encountered in 1993 hydroponic experiment by conducting the whole experiment, from seed germination to harvest, in pots filled with potting mix. By this means we eliminated the transplanting shock, root cracking and root fungal infection (in the 1993 experiment, the storage roots cracked when they expanded into the lids of the nutrient solution container; this led to fungal infection). The fluorescence measurements were carried out in the greenhouse daylight conditions. This required the use of special adapters to dark-adapt portions of the intact leaves in situ before measuring fluorescence emission under daylight illumination.

Three weeks after sowing seeds directly into the soil, chlorophyll fluorescence of the attached leaves was measured using the pulse modulation chlorophyll fluorometer Model PAM 101 (H. Walz, Effeltrich, FRG). At the end of the fluorescence measurement period (5 days), the 30 plants exhibiting the highest values and the 30 plants with the lowest values of each of the two fluorescence parameters, $F(V)_s$ and F_v/F_m , were selected (giving a total of 96 plants) and transferred into larger pots (each pot containing approximately 10 kg soil mix). The plants were allowed to grow in these pots for another 6 weeks after which they had reached sufficient size for harvesting. At harvest, we measured storage root sugar yield and percentage storage root sucrose as well as fresh and dry weights of plant parts. All the 96 plants were tested for statistical correlations between sucrose percentage or root sugar yield, with $F(V)_s$ or F_v/F_m as well as other fluorescence parameters that were measured at the early young seedling stage of growth.

We are very excited to report that this year we have obtained very highly significant statistical correlations between root sugar levels and fluorescence yield. The results show that there is a very highly significant correlation ($P < 0.001$) between F_v/F_m and storage root sucrose concentration. Young plants selected for low values of F_v/F_m subsequently exhibited storage roots with high sugar concentrations ($P < 0.001$) and high total sugar yield ($P < 0.05$) (Fig. 1a,b). Similarly, young plants selected for low values of F_v , developed storage roots with high sugar concentrations ($P < 0.05$) and high total sugar yield ($P < 0.05$).

Other significant correlations were obtained when fluorescence parameters other than F_v , or F_v/F_m were considered. We found that high storage root sugar concentration correlated negatively with low values of F_v ($P < 0.01$) (Fig. 2a), $F_v/(F_v)_m$ ($P < 0.001$) (Fig. 3a), $F_o + F_v$ ($P < 0.01$), and q_Q/q_E ($P < 0.05$), and correlated positively with high values of $q_E \cdot (F_v)_m$ ($P < 0.01$), q_q ($P < 0.001$), q_E ($P < 0.01$). Total storage root sugar yield correlated negatively with F_v (Fig. 2b), $F_v/(F_v)_m$ (Fig. 3b), q_Q/q_E , and correlated positively with $q_E \cdot (F_v)_m$.

Furthermore, when we selected the five plants exhibiting the highest values and the five plants with the lowest values (out of the 96 selected plants) for each of the fluorescence parameters measured, we found that the average sugar concentration and total sugar yield per plant differed significantly between the two groups of plants (Fig. 4a, b). For instance, the average sugar concentration for the five plants with the highest and five plants with the lowest values of F_v/F_m was $9.38\% \pm 1.27$ and $11.48\% \pm 0.72$, respectively.

These results are striking in that they show that fluorescence yield is very highly correlated with storage root sucrose concentration. This is the first time that there has been such an unequivocal demonstration that leaf (chlorophyll) fluorescence depends on the ability of the plant to store sucrose in its storage root as well as on its ability to produce sugar photosynthetically in the leaf. These results are exciting in that they show that leaf fluorescence can accurately predict which individuals in a population can store sugar at high concentrations in storage roots. By screening sugar beet genotypes which are known to produce large storage roots, it should be possible to develop new genetic lines with superior yield potentials. Specifically, selection for low values of F_v/F_m will identify those individual plants which will most probably have high sugar concentration in their storage yield at harvest.

Objectives 1995-1996:

After developing a simple, easily-workable experimental procedure for using pulse-modulated fluorescence analysis in the identification of superior-yielding sugar beet genotypes, the objective of our research in 1995 is to apply this technique for the actual development of new better-yielding varieties. Thus, we wish to screen a large population of sugar beet genotypes of appropriate genetic background and select those individual plants which are expected to have highest and lowest sugar yield in their roots based on their fluorescence characteristics. These selected plants will then be grown in soil in the greenhouse under the appropriate environmental conditions for seed production. The second generation obtained from these seeds will then be grown and evaluated for sugar yield.

Materials and Methods:

Seeds of appropriate genetic background (obtained from lines that were selected for large storage root size) will be provided by VAN DER HAVE RESEARCH, The Netherlands. The seeds will be sown in vermiculite and placed in a controlled environment greenhouse. After two weeks, 15 uniform germinated seedlings from each seedlot will be transplanted to plastic pots (one plant per pot, 5 cm in diameter) filled with a mixture of peat moss and vermiculite. These seedlings will be grown for two weeks in the greenhouse at 25°C with a minimum photon flux density of 1000 $\mu\text{mol m}^{-2} \text{s}^{-1}$ supplied over a 16-hour day. The seedlings will be watered daily with half strength Hoagland's solution.

After two weeks, chlorophyll fluorescence of the attached leaves will be measured using the pulse modulation chlorophyll fluorometer Model PAM 101 (H. Walz, Effeltrich, FRG).^{*} Plants to be measured on a certain day will be placed in a dark section of the greenhouse. One plant at a time will be placed in the light for two hours, then the most rapidly expanding attached leaf will be dark-adapted with a special adapter and the fluorescence measurements made. At the end of the fluorescence measurement period, the 15 plants exhibiting the highest values and the 15 plants with the lowest values of each of the three fluorescence parameters, F_v , F_v/F_m and $F_v/(F_v)_m$, will be selected and transferred into larger plastic pots containing the same potting medium (one plant only per pot).

All the selected plants will be allowed to grow in pots in the greenhouse until maturity. All plants will be watered daily with half-strength Hoagland's solution. The plants, which will initially be arranged randomly, will be re-randomized at weekly intervals to minimize environmental variation. The plants will be photothermally induced for bolting by exposing them to a period of cool temperature followed by a period in which the daylight hours are long. After approximately another two months from the time seedstalks begin to form, the seed crop will be ready to harvest.

The seeds collected this way will be planted and grown as described above except that the plants will not be induced. Instead all plants will be harvested when they yield about 1 kg total plant fresh weight (about 8 weeks from seed emergence). Before harvest chlorophyll fluorescence will be measured as described below. At harvest, all plants will be separated to shoots and roots, sugar content measured in storage roots, and total fresh and dry weights recorded. These results will then be subjected to statistical analyses to test for significant correlations between the fluorescence parameters and sugar beet yield of the new generation, i.e., to determine whether the difference in root sugar yields between the high and low fluorescence populations is genetically heritable.

^{*}Chlorophyll fluorescence emission from the top side of the most rapidly expanding attached leaf will be measured using a pulse modulation fluorometer (Model PAM, H. Walz, Effeltrich, FRG, including a PAM 101 control unit, the 101 ED emitterdetector unit, the 101 F fiberoptics, the PAM 103 accessory module unit, and the FL 101 fiberilluminator). The terminal end of the optical fiber bundle (which provides actinic light, the measuring beam and conducts the fluorescence emission to the detector) will be in close contact with the upper surface of the leaf.

The measurement will proceed as follows: plants will first be illuminated for 2 hours in the greenhouse, then the selected leaf will be dark-adapted with a special adapter for 20 minutes. The minimal fluorescence level, F_o , will be taken as the fluorescence intensity of the dark-adapted leaf after the measuring light is switched on ($0.05 \mu\text{mol m}^{-2} \text{s}^{-1}$ modulated at 1.6 kHz). The maximal fluorescence level, F_m , will be induced by applying a saturation light pulse of $4000 \mu\text{mol m}^{-2} \text{s}^{-1}$, 800 ms in duration. After another 20 s, when the signal is relaxed to near F_o , brief saturating pulses of actinic light ($4000 \mu\text{mol m}^{-2} \text{s}^{-1}$, 800 ms in length) will be applied repetitively for 30 s with 2 s dark intervals. The photochemical and non-photochemical quenching components (q_Q , q_E , F_v , $(F_v)_m$, $(F_v)_s$) will be determined from the fluorescence/ time curve (i.e., changes occurring in initially dark-adapted then light-pulsed leaf) using the equations of Schreiber (1986).

SUGARBEET RESEARCH

1995 Report

Section B

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Abstracts of Papers Published or Approved for Publication

Owens, L.D. 1995. Strategies for developing horticulturally useful genes: Overview of gene availability, identification and regulation. *HortScience* 30(5):957-961.

Increasingly, in the future, American agriculture will need to depend on value-added crops for economic viability. The method of choice for introducing important, value-adding genes into elite lines of horticultural crops will be gene transfer. Other classes of organisms will continue to be an important source of value-adding genes for transfer to plants, however techniques for cloning plant genes currently known only by phenotype will provide an ever-growing new source of genes for this purpose. Knowledge of the molecular biology of gene transcription and translation now enable modification of transgenes to optimize their expression in the target plant or tissue. Further knowledge of the relationship between protein structure and susceptibility to protease action may guide the engineering of genes to enhance protein accumulation levels. This review of recent advances in the genetic engineering of plants will be of use to horticulturists and plant breeders in general.

Kwon, Y-C., J-G. Gwag, S-B. Pae, C-Y. Kim, H-S. Suh, and L.D. Owens. 1994. Introduction of macromolecule in PEG/Electroporated cells of sugar beet. *RDA J. Agr. Sci.* 36:191-195.

An efficient foreign macromolecule introduction protocol using polyethylene glycol and electroporation was developed for *Beta vulgaris* suspension culture cells. Cells were treated with 30 % polyethylene glycol and 10 µg/ml fluorescein isothiocyanate-dextran (150 kDa). The treated cells were then electroporated. Following an incubation period of 30 min, it was observed by spectrofluorometry that uptake of FITC-dextran was increased several times. PEG treatment with electroporation was more efficient than electroporation only. Uptake of FITC-dextran was increased by pulse number, but field strength did not affect FITC-dextran incorporation. The viability of cells was reduced by PEG treatment and electroporation.

Huang, Y., R.O. Nordeen, M. Di, L.D. Owens and J.H. McBeath. 1996. Expression of an engineered cecropin gene cassette in transgenic tobacco plants confers disease resistance to *Pseudomonas syringae* pv. *tabaci*. *Plant Sci.* In press.

A chimeric gene fusion cassette consisting of a secretory sequence from barley α -amylase joined to a modified cecropin (MB39) coding region and placed under control of the promoter and terminator from potato proteinase inhibitor II (PiII) gene was introduced into tobacco by *Agrobacterium*-mediated transformation. Transgenic and control plants reacted differently when inoculated with tobacco wildfire pathogen *Pseudomonas syringae* pv. *tabaci* at various cell concentrations. With control plants (transformed with PiII-GUS gene fusion), a

clear necrosis was observed in leaf tissue infiltrated with bacterial levels of 10^2 , 10^3 , 10^4 , 10^5 and 10^6 cfu/ml. With MB39-transgenic plants, however, necrosis was observed only in the areas infiltrated with the two higher levels (10^5 and 10^6 cfu/ml). No necrosis was evident in areas infiltrated with bacterial concentrations 10^4 cfu/ml or less. Bacterial multiplication in leaves of MB39-transgenic plants was suppressed more than 10-fold compared to control plants, and absence of disease symptom development was associated with this growth suppression. We conclude that the pathogen-induced promoter and the secretory sequence were competent elements for making a cecropin gene into an effective disease-control gene for plants.

Ingersoll, J. C. , T. M. Heutte, and L. D. Owens. (1996) Effect of promoter-leader sequences on transient expression of reporter gene chimeras biolistically transferred into sugarbeet (*Beta vulgaris*) suspension cells. Plant Cell Reports. In press.

Chimeric constructs consisting of the *gus* coding region fused downstream of promoter-untranslated leader sequences from the tobacco osmotin and PR-S genes, the potato proteinase inhibitor 2 gene (*pin2*) , and the cauliflower mosaic virus (CaMV) 35S promoter were biolistically transferred into sugarbeet suspension cells. Each construct was expressed in recipient cells at 6 h after bombardment with maximum levels observed between 12 and 48 h. Expression of the PR-S construct mimicked the time-course expression of the constitutively expressed 35S construct but reached levels almost 50% higher. The *pin2*-promoter construct was ultimately expressed at levels similar to that of PR-S. Expression of the osmotin promoter-leader construct was highest, reaching levels approximately 2.5-fold higher than those of the 35S construct.

ENGINEERED RESISTANCE TO BACTERIAL PATHOGENS *BSDF Project 800*

Gordon Snyder, John C. Ingersoll and Lowell D. Owens

Production of cecropin-transgenic sugarbeets - Having previously shown that synthetic cecropin SB37 was toxic to *Erwinia carotovora* subsp. *betavascularum* (Nordeen et al., Plant Sci. 82:101-107, 1992), we designed a gene which is intended to secrete a modified cecropin polypeptide to the intercellular spaces of the plant. We called the modified cecropin MB39 because of its 39 amino acid residues. The toxicity of this small protein approximates that of both cecropin SB37 and their natural prototype cecropin B. Surprisingly, however, cecropin MB39 proved highly inhibitory to *Rhizoctonia solani* strain AG 2-2 isolated from infected sugarbeet roots (provided by William Bugbee). Generally, cecropins are known only as antibacterial proteins.

We first tested the gene construct in tobacco, an easily transformed crop. Transgenic tobacco carrying the cecropin MB39 gene suppressed the multiplication of *Pseudomonas syringae* pv. *syringae* bacteria injected into leaves, as detailed in the above abstract (Huang et al., 1996), and prevented symptom development.

Consequently, the coding region of MB39 was placed under control of several highly expressed promoters (Fig. 1). Two of the constructs, osmotin→cecropin MB39 and PinII→cecropin MB39, were successfully introduced into sugarbeet line Rel-1. The transformation method we developed is as follows. Seeds were germinated for 3 weeks in the dark at 27°C on MS medium supplemented with 1.0 mg/l 6-benzylaminopurine (BA), and 0.5 mg/l 2,3,5-triiodobenzoic acid (TIBA). Shoots and roots were removed from the seedlings and the hypocotyls were cut into 1 to 2 cm sections and placed on MS medium containing 1.0 mg/l BA. Hypocotyls were incubated in the dark at 30°C for 4 to 8 weeks.

Embryogenic callus produced on the cultured hypocotyls was harvested, spread on sterile, filter-paper discs on MS medium containing 0.3 mg/l BA, 0.1 mg/l α -naphthaleneacetic acid (NAA), and osmoticum (0.25 M). Following a 4-hour incubation, the callus was subjected to particle bombardment using gold micro-particles coated with plasmid DNA containing a promoter-cDNA fusion. After 3 d, the callus was transferred to MS medium containing 1.0 mg/l BA, 200 mg/l cefotaxime, and 200 mg/l kanamycin and incubated in the light at 24°C.

Transgenic shoots were multiplied by micropropagation, rooted on NAA and are being grown to maturity for seed production and testing against *E. carotovora* subsp. *betavascularum*. and *R. solani*.

Production of thionin-transgenic sugarbeets - Since cecropins are not inhibitory to *Cercospora beticola*, or to fungi in general, we chose to add a second gene to the project---a pathogen-inducible α -thionin gene from barley. Thionins are small (~5 kD and ~50 amino acid residues), cysteine-rich (5-8 cysteines) antimicrobial proteins classified according to the conserved spacing of their cysteine residues. The one we chose to work with, DB4 thionin, is highly inhibitory to *C. beticola* and moderately toxic to strains of *E. carotovora* subsp. *betavascularum* (lethal concentration = 6.8 μ M) provided to us by Chris Wozniak.

As in the case of cecropin, we placed the DB4 thionin gene under control of several highly expressed promoters. At this writing we have obtained sugarbeets transgenic for PinII \rightarrow thionin and PR-S \rightarrow thionin. The promoters correspond to those assayed in sugarbeet suspension cells (see Ingersoll et al., abstract).

Production of Osmotin-transgenic Sugarbeets - A second antifungal protein added to the project is osmotin, originally cloned from tobacco. As in the case of thionins, there are many osmotin-like proteins produced by plants, and they display different antifungal specificities. Osmotin is a larger protein (24 kD) and, like thionin, cysteine-rich (16 cysteines). We have succeeded in obtaining sugarbeets transgenic for osmotin under regulatory control of its own promoter which is inducible by numerous biotic and abiotic stresses, including fungal infection.

Promoter-GUS Tests in Transgenic Sugarbeets - Although we have examined the activity of various promoter- β -glucuronidase (GUS) constructs in sugarbeet suspension cells (see Ingersoll et al., abstr. above) we were able to transform two of them, osmotin \rightarrow GUS and PinII \rightarrow GUS, into sugarbeet for whole-plant comparisons. GUS activity in leaves of an osmotin-GUS plant was found to be inducible by wounding, with peak activity occurring at about 48 hours.

GENE TRANSFER RELATED TO SUGAR PARTITIONING

Gordon. W. Snyder, John C. Ingersoll, and Lowell. D. Owens

Cytokinin [*ipt*]-transgenic Sugarbeets - A tuber-constitutive promoter from potato---the patatin promoter--- was attached to the coding region of the cytokinin biosynthesis gene [*ipt*] from *Agrobacterium tumefaciens*. Two independent transformants of sugarbeet have been obtained. While the transformed shoots were easily multiplied by micropropagation techniques, rooting has been problematic---presumably due to elevated cytokinin levels in the shoots. Furthermore, one self-rooted plant taken to maturity produced abnormal, sterile flowers. Grafting of these transgenic shoots onto roots of a normal sugarbeet may enable fertile seed production.

The primary goal of this gene introduction experiment is to increase the sink strength of the sugarbeet taproot. The hypotheses to be tested are that 1) the patatin promoted *ipt* gene will be highly expressed in sugarbeet taproot, thereby leading to high cytokinin levels and that 2) high cytokinin levels will lead to increased cell division, additional vascular rings and increased sucrose yield.

CONSTRUCTION OF GENES FOR SUGARBEET

John Ingersoll and Lowell D. Owens

Gene Constructs for Use in Sugarbeet - Since so little work has been done with transgenic sugarbeets and since we cannot predict how well a particular promoter and gene will be expressed in sugarbeet, we have prepared a number of promoter-gene permutations for testing (Fig. 1).

Coding regions - The first gene coding region shown in Fig. 1 is *gus* (*uidA* from *Escherichia coli*) encoding β -glucuronidase. This reporter gene is used to analyze how well each of the five promoters is expressed in a particular tissue of the plant and under what conditions and timing its expression is induced.

Of the four pathogen defense genes employed, the antimicrobial properties of three, cecropin MB39, thionin and osmotin, have been discussed above. PR-S (pathogenesis related protein-S of tobacco) is an osmotin-like protein but is secreted extracellularly, while osmotin is targeted to the vacuole. PR-S was selected because it is reported to be about twice as potent as osmotin in inhibiting growth of *C. beticola* hyphae.

Promoters - Of the four promoters employed in the constructs, the 35S (cauliflower mosaic virus 35S) promoter is highly expressed in a number plant tissues, however there is little evidence for expression in root parenchyma cells. Since storage cells in taproots are parenchyma cells, we doubt that 35S will adequately express genes targeted for those cells.

As mentioned above, the tobacco osmotin (OSM) promoter is inducible by many factors, including viral and fungal infections, wounding, ethylene, abscisic acid, salt, salicylic acid, methyl jasmonate and low water potential.

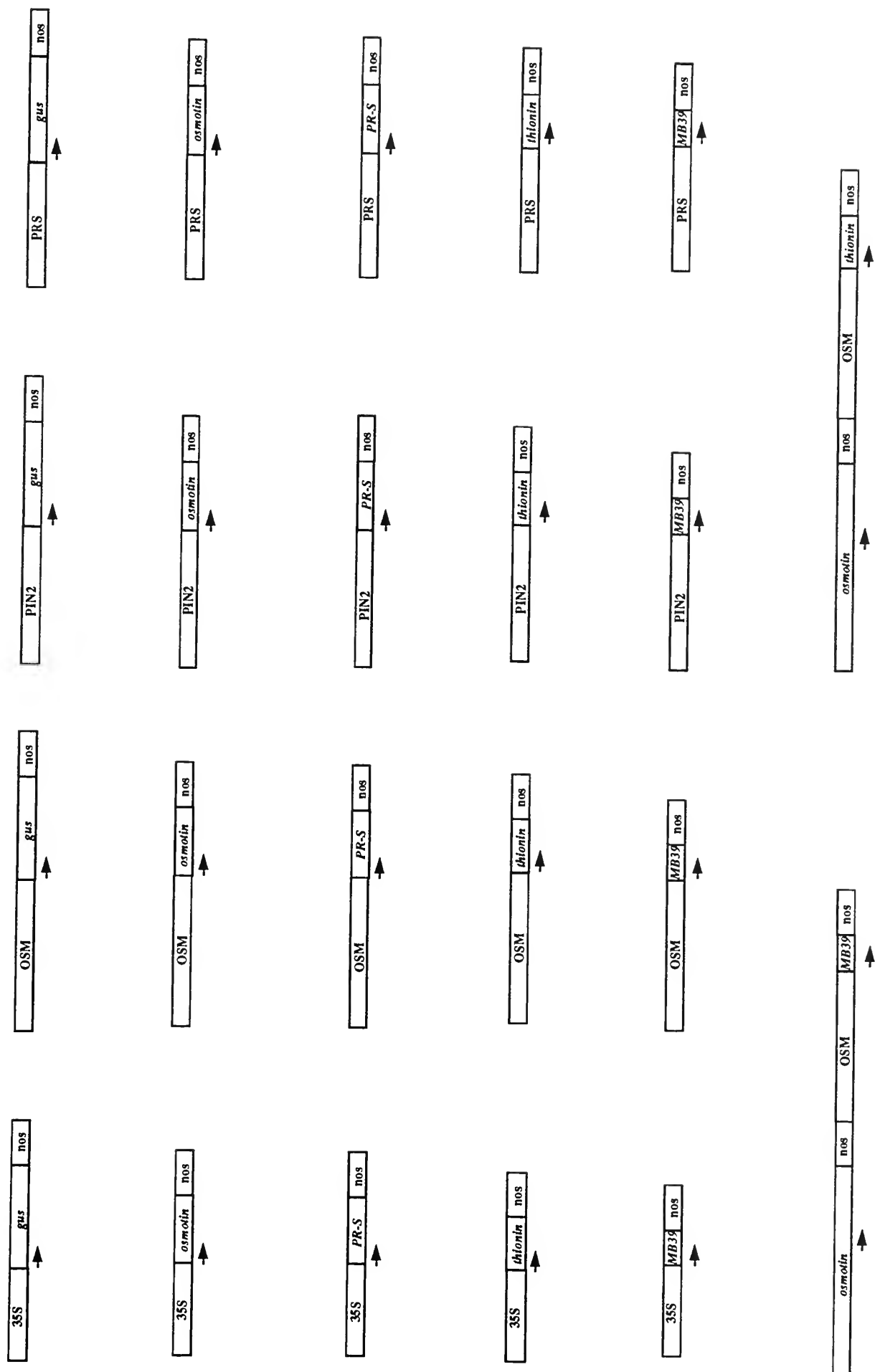
PIN2 (proteinase inhibitor II from potato) is constitutively expressed in potato tubers and flowers but systemically induced in foliage by wounding, fungal infection, jasmonic acid and abscisic acid. Further, expression of PIN2 is enhanced by sucrose.

Lastly, PR-S is inducible by virus infection, salicylic acid, ethylene and UV light. It is not induced by wounding.

In addition to the single-gene constructs, two dual-gene cassettes have been prepared (Fig. 1). One combines the entire osmotin gene with cecropin MB39 under regulation of the osmotin promoter. The other combines osmotin with the thionin gene, also regulated by the osmotin promoter.

All of these constructs are available to researchers for introduction into sugarbeet.

Figure 1. Promoter/gene constructs for introduction into sugarbeet.



SUGARBEET RESEARCH

1994 REPORT

Section C

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- RUPPEL, E. G., HECKER, R. J., and PANELLA, L. W. 1995. Registration of two sugarbeet germplasms resistant to *Rhizoctonia* root rot: FC715 and FC715CMS. *Crop Sci.* 35:290.

Artificial Epiphytotics of Rhizoctonia Root Rot and Cercospora Leaf Spot: Consistency of Disease Intensity Over Time. Lee Panella and Earl G. Ruppel. USDA-ARS Sugarbeet Research Unit; 1701 Centre Avenue; Fort Collins, CO 80526; U.S.A.

Each year, artificial *Rhizoctonia* root rot and *Cercospora* leaf spot epiphytotics are established in the field at Fort Collins, Colorado, U.S.A., to evaluate sugarbeet resistance to these diseases. The USDA-ARS Sugarbeet Research Unit at Fort Collins has used a cyclic mass selection program in these nurseries to breed sugarbeet germplasm resistant to these two diseases. In the last twenty-five years over 30 *Rhizoctonia* root rot resistant and 20 *Cercospora* leaf spot resistant germplasms have been released from this program. Additionally, these nurseries have been used to evaluate the resistance of sugarbeet lines submitted by Beet Sugar Development Foundation member companies and of *Beta* plant introductions from the U.S. National Plant Germplasm System.

We continue to use these nurseries in our present breeding program; however, to produce reliable results, it is necessary to be able to create adequate epiphytotics under varied environmental conditions. The manipulation of the field experiment micro-environment has allowed us to maintain reasonable consistency of disease intensity in resistant and susceptible controls across experiments and years. To illustrate this consistency, we will present data obtained from these nurseries over the past fifteen years.

We also have examined the influence of interplot interference in the *Cercospora* leaf spot nursery. This could be a problem in small plot work, especially with a sporulating foliar pathogen which causes multiple disease cycles in a single season. Significant interference might cause erroneous results resulting in lower relative ratings in experiments in which the majority of the lines were susceptible.

We are confident that our field techniques provide the consistent epiphytotics necessary to continue selecting resistant germplasms and to test the resistance of sugarbeet lines to these diseases.

Optimizing the Commercial Production of Sugarbeet Clones In Vitro. L. Panella and C. Rivera Smith. USDA-ARS Crops Research Lab, Ft. Collins, CO 80526 (970 498-420) and Summit Plant Laboratories, Inc., 2301 Research Blvd., Suite 106, Ft. Collins, CO 80526 (970 224-2021)

Sugarbeets (*Beta vulgaris*, L.) and sugar cane (*Saccharum* spp.) are the major crops refined to produce sugar. Most of the sugar produced in this country comes from sugarbeet, and the plant is an economically important crop throughout the Northern Hemisphere. Sugarbeet is a cross-fertilizing, self-incompatible species. This results in each individual plant within a population having a distinct genotype. Genetic improvement of this important crop, with traditional or new biotechnological methods, could be enhanced significantly through the increased availability of clonally propagated plants. Researchers in private companies and at public institutions are well aware of this potential, and a search of the literature reveals designs in which clonal material could and has been used to improve this crop. Sugarbeet clones can be used to : 1) quickly multiply genetically engineered genotypes, 2) produce hybrid seed for combining-ability tests, 3) reduce the chances of producing chimeric tetraploids, and 4) minimize the space needed to maintain genotypes undergoing progeny (or clonal) testing. Clonal propagation also provides a means for maintaining important genotypes, such as mutants, haploids, parents for genetic studies, cell culture selections, and progeny from F₂ mapping populations. The USDA Agricultural Research Service and Summit Plant

Laboratories, Inc. (SPL) have a Cooperative Research and Development Agreement with the goal of optimizing the commercial production of sugarbeet clones by SPL. The availability of commercially produced sugarbeet clones could provide a powerful tool in the improvement of sugarbeet germplasm for public and private researchers who do not have access to the facilities necessary to produce clonal material on a research or production scale.

Genetic diversity among isolates of *Rhizoctonia* root rot pathogenic to sugarbeet. PANELLA, LEE^{1*} and Mary K. Hjort², USDA, Agricultural Research Service, 1701 Center Ave., Fort Collins, CO 80526 and Colorado State University, Department of Physiology, Fort Collins, CO 80523.

Currently, it is possible to assay the pathogenicity to sugarbeet of an isolate of *Rhizoctonia solani* through a greenhouse bioassay only, which may take 12 to 16 weeks. Recent work done on the phylogenetics of this pathogen has not been well correlated with the host specificity of the fungus. Whether the pathogenicity to sugarbeet has evolved once or more than once in this fungus could substantially influence its interaction(s) with the sugarbeet plant. *R. solani* is divided into anastomosis groups (AGs) based on the ability of the hyphae to fuse and exchange genetic material, or, more recently, into intraspecific groups (ISGs) based on molecular markers. The polymerase Chain Reaction (PCR) was used with the ITS1 and ITS4 primers to amplify the DNA of *R. solani* coding for the 5.8S ribosomal RNA gene (rDNA) as well as the two flanking ITS regions. Six restriction enzymes, Alu I, Hae III, Hha I, Hinf I, Hpa II, and Rsa I, were used to create restriction fragment length polymorphisms (RFLPs) from the amplified DNA fragments. Data from 92 isolates of *R. solani* were analyzed using the SIMQUAL program (NTSYS-pc from Exter Software) based on Jaccard's coefficient. The resulting similarity matrix was used to create a phenogram. There was good discrimination between AG-2-2 (causal agent of sugarbeet crown and root rot) and the other AGs, but not adequate discrimination within this AG or among the other AGs. More genetic markers are needed to discriminate adequately. Isozyme markers from four enzyme systems (α - Acid phosphatase (α -ACP), Phosphoglucosmutase (PGM), Glucose-6-Phosphate-dehydrogenase (G6PDH), and Malate dehydrogenase (MDH)) are being screened to further distinguish among isolates. Greenhouse tests will be used to determine the pathogenicity of the isolates of *R. solani* to sugarbeet. These data will be correlated with the phylogenetic information to genetically "fingerprint" those isolates pathogenic to sugarbeet.

Use of Clones in a Sugarbeet Improvement Program. L. PANELLA and C. Rivera Smith. USDA-ARS Crops Research Lab, Ft. Collins, CO 80526 and Summit Plant Laboratories, Inc., 2301 Research Blvd., Suite 106, Ft. Collins, CO 80526

Sugarbeet (*Beta vulgaris*, L.) is a cross-fertilizing, self-incompatible species. This results in each individual plant within a population having a unique genotype. Sugarbeets produce most of the sugar grown in this country; the crop is an economically important crop throughout the Northern Hemisphere. Plant Breeding and genetic improvement of this important crop, with traditional or new biotechnological methods, could be significantly enhanced through the increased availability of clonally propagated plants. A search of the literature reveals designs in which clonal material could and has proved valuable in a traditional breeding scheme. Sugarbeet clones can: 1) facilitate the

production of hybrid seed for combining ability tests, 2) reduce the chances of producing chimeric tetraploids, and 3) minimize the space needed to maintain genotypes undergoing progeny (or clonal) testing. A theoretical examination of the use of clones in selection schemes shows that the potential increased efficiency of selection is proportional to the amount of genetic variation masked by the environmental variation present within the population. Clonal propagation also provides a means for maintaining important genotypes, such as mutants, haploids, parents for genetic studies, cell culture selections, and progeny from F₂ mapping populations. The availability of commercially produced sugarbeet clones could provide a powerful tool in the improvement of sugarbeet germplasm for public and private researchers who do not have access to the facilities necessary to produce clonal material on a research or production scale.

Registration of FC725, FC726, and FC728 Sugarbeet Germplasms Resistant to Rhizoctonia Root Rot and Moderately Resistant to Cercospora Leaf Spot. L. Panella and E. G. Ruppel. USDA-ARS Crops Research Lab, Ft. Collins, CO 80526

The USDA Agricultural Research Service (ARS), in cooperation with the Beet Sugar Development Foundation (BSDF), has released three sugarbeet germplasms. FC725 is multigerm (*M*), non O-type, self-sterile, and has 44 percent green hypocotyls. It resulted from the cross C37 x FC707/2. FC725 had excellent resistance to Rhizoctonia root rot when tested under strong disease pressure. FC725 also shows some resistance to Cercospora leaf spot. FC726 is multigerm (*M*), non O-type, self-sterile, and has 46 percent green hypocotyls. It resulted from the cross FC703/3 x Peramono. Peramono is a fodderbeet with relatively high sucrose and medium Rhizoctonia root rot resistance, detected in the exotic germplasm screening program of R.J. Hecker. Peramono might represent another source of resistance to Rhizoctonia root rot, and crossing with the Rhizoctonia resistant parent FC703/3 could lead to transgressive segregants for Rhizoctonia resistance, but this has not been tested. FC726 had excellent resistance to *R. solani* when tested under strong disease pressure. FC728 is multigerm (*M*), non O-type, self-sterile, and has the sterile cytoplasm. It has 26 percent green hypocotyls. FC728 resulted from a population derived of equal numbers of F1 plants (90) from three crosses: Mono-Hy A4 x FC708, Mono-Hy D2 x FC708, and Mono-Hy 309 x FC708. True hybrids were selected with hypocotyl color as a marker. Because of the productive hybrids as parents, FC728 should be a good source of parents with high combining ability. Because of the genetic background, it should also be possible to isolate monogerm, O-type, and CMS genotypes. When tested under strong disease pressure, FC728 had excellent resistance to *R. solani*. FC728 showed moderate resistance to Cercospora leaf spot. Each germplasm was developed from genetically different and distinctive sources. They are potential pollinators or populations from which to select or produce pollinators with combined disease resistance.

FUNGI ISOLATED FROM DIFFERENT SUGARBEET SEEDLOTS (BSDF Project 404)

Pathogenicity Tests with Selected Fungal Isolates from Six Sugarbeet Seedlots -- E. G. Ruppel.

Fungi (25 isolates) from seedlots produced in Oregon, our local field isolation plots, or in greenhouse isolation cages were maintained in pure, monoculture and tested for pathogenicity to sugarbeet. Isolates were either introduced individually to sugarbeet seed via vacuum infiltration (16 isolates) and then planting in pasteurized soil, or by planting in soil infested with test isolates (8 isolates) in replicated tests in the greenhouse. One isolate of *Cercospora* was induced to sporulate, then a conidial suspension of this isolate was sprayed onto sugarbeet that, subsequently, were kept in a high humidity (RH = 95%) chamber for 4 days before placing them on the greenhouse bench. Additionally, nontreated seed of each seedlot were planted in steam-pasteurized soil.

Of the 16 isolates vacuum-infiltrated into sugarbeet seed, 13 reduced seedling emergence (percent of control emergence) from 5.9 to 37.1%. Isolates inducing only 5.9% reduction included one *Stemphylium* isolate and one *Phoma* isolate. One isolate of *Stemphylium* reduced emergence by 37.1%. Other isolates of *Alternaria*, *Phoma*, and *Stemphylium* reduced emergence from 10.0 to 29.4%. Although emergence was reduced, no postemergence damping-off was observed with any isolate. The eight isolates that were used to infest soil into which sugarbeet seed was planted reduced seedling emergence from 15.9 to 51.1%; again, no postemergence damping-off occurred. These eight isolates included four unknowns (no spores), *Fusarium equiseti*, *F. solani*, *Nigrospora*, and a binucleate *Rhizoctonia*. *F. solani* reduced emergence the most (51.1%). There was no reduction in seedling emergence or postemergence damping-off from nontreated seed planted in pasteurized soil. The one isolate of *Cercospora* induced typical leaf spots in inoculated sugarbeets.

It is unclear why no seedling disease or reduced emergence occurred when seed of the six seedlots were planted in pasteurized soil, yet reduced emergence did occur from seeds that were individually vacuum-infiltrated with 13 of 16 fungi, or from seeds planted in soil infested with eight other fungal isolates from seed. Perhaps, it involves a concentration phenomenon whereby the seed or soil treatments provided exceedingly high concentrations of the test fungi that are capable of either causing disease directly as pathogens or indirectly by reducing emergence via competition for needed nutrients. The vacuum-infiltration treatment also may be suspect as causing some seed damage; however, three isolates did not cause any reduced emergence. Meanwhile, unless a fungus isolated from seed induces visible disease symptoms upon inoculation to healthy plants, and that fungus can be reisolated from the plant tissue, Koch's postulates cannot be fulfilled and proof of pathogenicity must be considered lacking.

**RHIZOCTONIA ROOT ROT RESISTANCE AND DEVELOPMENT OF
GENETIC RESISTANCE IN SUGARBEET
(BSDF Project 440)**

1995 Field Research on Rhizoctonia Root Rot of Sugarbeet. -- E. G. Ruppel and L. Panella.

We have been pleased to participate and lead this cooperative research project of ARS, the BSDF, and the Colorado Agricultural Experiment Station. The project primarily involved field studies conducted on the Colorado State University (CSU) South Campus in an area reserved for Rhizoctonia root rot research and in laboratory studies conducted in the Crops Research Laboratory (CRL) and CRL greenhouses. Because CSU needs the South Farm land for construction purposes, future field research will be conducted on 35 acres of leased land near Windsor, CO. Previously, the only cost to ARS for land at the South Farm was our cost for irrigation water. In preparation for the 1996 field season, the land at the Windsor location was planted in barley in 1995.

Our 1995 field experiments were planted in an area that had been in barley for 3 years, having been the site of our root rot nursery in 1991. Only three sugarbeets infected with *Rhizoctonia solani* were found before we inoculated with the fungus in 1995. Thus, our 4-year rotation with barley again proved sufficient for the degradation of *Rhizoctonia*-infective propagules in our low-organic soils.

As usual, root rot evaluation tests were planted in one-row plots 56 cm (22 in) apart and 4.3 m (14 ft) long. Experiments were planted in mid-May and thinned to a 20- to 25-cm (8- to 10-in) in-row spacing about the third week in June. Dry, ground, barley-grain inoculum of *Rhizoctonia solani* (isolate R-9) was banded over the rows on July 26 at a rate of 8.4 g/4.3-m row with a tractor-mounted four-row granule applicator. Inoculum was banded in a split application, with opposite directions of travel for each application. Immediately after inoculation, we performed a cultivation designed to throw soil into sugarbeet crowns, a practice that is conducive to the development of root and crown rot. Inoculum was moistened and carried into the crowns by overhead sprinkler irrigation, which was applied immediately after inoculation and then intermittently for the next four days. Succeeding irrigations were done by furrow. Before field inoculation, we tested inoculum for virulence on 2-mo-old sugarbeets in the greenhouse; our 1995 inoculum was highly virulent, rotting all inoculated plants.

Roots in all tests were lifted the week of September 18 and individually rated for rot on a disease index (DI) scale of 0 to 7, with 0 = no evidence of rot and 7 = plant dead. Percent healthy roots were those with DIs of 0 and 1, roots with no active infection. Roots with DIs 0 through 3 also were analyzed as a class; these roots were sufficiently sound and large to be recovered in a commercial harvest.

Rhizoctonia-Resistant Populations for Multiple Disease Resistance in Sugarbeet -- L. Panella.

In a hybrid crop like sugarbeets, it is preferable that all of the parents contain some level of resistance to diseases prevalent in the area in which the hybrid is to be grown. Multiple disease resistance is a difficult goal in a crop improvement program, especially when working with an outcrossing species. In alternating generations of selection, some of the progress made in resistance to one disease is lost while selecting for resistance to other diseases.

One way of solving the problem of selecting for multiple disease resistance is the use of progeny testing. By testing the progeny of individual mother roots, plants with multiple disease resistance can be identified and used as parents of the next generation. The most efficient use of progeny testing is when the genotype of both parents is known, and the easiest way to do this is through self-pollination. In sugarbeet, there is a dominant, self-fertility gene that permits self-pollination. Used in conjunction with genetic male sterility, to insure cross pollination, a system of full-sib progeny testing can be utilized. Material from the USDA-ARS breeding program at Salinas, CA, has been crossed with some of the Fort Collins lines most resistant to *R. solani* and *C. beticola*. The Salinas material has the self-fertility allele, is segregating for genetic male sterility, and also contains a broad spectrum of resistance to diseases of importance in California as well as other sugarbeet production areas (including rhizomania, powdery mildew, virus yellows, and curly top virus).

Two source populations are being developed. A multigerm population (961004) was grown in the field at Fort Collins in 1995. It consists of the cross 921024/93A001 (FC709-2/2915 (sp) RZM) and its reciprocal. This population is currently being bulk increased in the greenhouse.

The other population (961008) is monogerm and segregating for Rhizoctonia root rot and other disease resistances, self-fertility, and genetic male sterility. It consists of equal amounts of bulked seed from the crosses, 2890 (sp)/FC708, 2859 m (sp)/FC708. Individual F₂ mother roots from the 1995 field are being selfed in the Greenhouse over winter.

The multigerm population will be planted in the field in 1996 at Fort Collins. Mother roots harvested from the 1996 field will be selfed in the greenhouse and progeny tested in 1997. Selfed seed from the individual F₂ mother roots of the monogerm population will be progeny tested in the Rhizoctonia root rot nursery at Fort Collins and the curly top nursery in Kimberly Idaho. Selected families will be recombined and further improved.

These populations, together with the materials from Dr. Hecker's program and the populations in the combined Cercospora resistance breeding program (from Fargo and Fort Collins), will form the basis of two breeding projects, each containing a strong laboratory component. One will focus on understanding the genetics of the *R. solani*-sugarbeet interaction and producing multiple disease resistance in sugarbeets. The other will focus on understanding the genetics of the *C. beticola*-sugarbeet interaction, and producing strong and stable host plant resistance.

Germplasm Development for Resistance to Sugarbeet Diseases -- L. Panella, E. G. Ruppel, and R. J. Hecker (retired).

Root rot and leaf spot are two serious diseases of sugarbeets caused by fungi (*Rhizoctonia solani* and *Cercospora beticola*, respectively). The diseases caused by these fungi may produce a severe reduction of yield in many sugarbeet production areas. Cultural control measures are not adequate by themselves, and often no chemicals are registered for control of these diseases, or chemical control is expensive or environmentally unsafe. Increased levels of genetic resistance in sugarbeet varieties are needed to minimize growers' losses from these diseases.

Genetic information developed previously in our research was used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our cyclic improvement program. Germplasms in various stages of improvement were evaluated for resistance in inoculated field tests. Results of these tests were the basis of decisions about specific germplasm, i.e., retain, shelve, discard, recombine, release, register, etc. Germplasms likely to be useful for variety improvement were identified and released for use by other sugarbeet breeders.

The lines FC725, FC726, and FC728 were released in 1995. The lines were developed in our research project that has been contributed to, in kind, by the Beet Sugar Development Foundation. The newly released lines combine excellent root rot resistance with a moderate level of leaf spot resistance. Germplasms developed under the breeding program of Dr. R. J. Hecker are still being evaluated in the field. Nine of these germplasms and other germplasms were field-tested this summer for resistance to *R. solani*, *C. beticola*, and the curly top virus (Tables 1-3). Some lines were also tested for resistance to Rhizomania by Dr. R. Lewellen at the USDA-ARS Station in Salinas CA (Table 4).

At least three lines showing outstanding performance in 1995 field trials will be released in 1996. More lines were selected for increased resistance to *Rhizoctonia* root rot in 1995 will be tested in 1996, and the most promising of these will be released in the future.

Table 1. 1995 Curly Top Nursery - Kimberly, ID.

Designation	Pedigree	Source	Mean DI ¹	
			1st	2nd
		LSD ²	0.84	0.87
FC403CMS	released	911043HO1	3.7	3.8
Beta G6040	Resistant control	94A068	3.5	3.8
FC604	released	921002HO	3.7	4.0
FC403	released	911043HO	3.7	4.2
	Highly inbred O-type	931016HO	4.3	4.3
FC721	Syn (FC701/LSR-CTR)//C718, mm	931005HO	4.3	4.3
	Highly inbred CMS	931016HO1	4.3	4.5
FC721CMS	C718CMS//Syn (FC701/LSR-CTR), CMS	931005HO1	4.3	4.7
FC605	released	831002HO	4.2	4.7
FC606	released	881036HO	4.5	4.7
FC720	C718//(C718/FC708), mm	931007	4.7	4.8
FC719	released	911037	4.2	4.8
FC716	released	911028	4.8	5.0
FC725	C37/FC707-2, MM - released	921008	4.8	5.2
FC717	released	911031	4.7	5.2
FC703-5	+ 5 cycles Rhizoc	921021	4.7	5.2
FC609	released	95A021	4.5	5.2
FC709-2	+ 2 cycles Rhizoc & 1 cycle sucrose	921024	4.8	5.3
FC726	FC703-5/Peramono, MM - released	931010	4.7	5.3
FC727	FC703/(AJ-ZZ & Aula Dei & 67-436), MM	921007	5.3	5.5
FC718	released	911032	5.0	5.5
FC729	FC712/A4, 3 cycles Rhizoc, MM	921019	5.2	5.5
FC728	(A4 & D2 & 309)/FC708, MM - released	921025	5.0	5.7
	L606 - Rhizomania resistant (French)	941004	5.3	5.7
FC702-7	+ 7 cycles Rhizoc	921022	5.2	5.8
FC708	released	831085HO	5.3	5.8
FC607	released	811003HO	5.7	5.8
FC710(4X)	FC710 colchicine doubled	941005	5.3	5.8
FC715	released	911026HO	5.7	6.0
	L599 ms - Rhizomania resistant (French)	941001H2	5.7	6.2
	L609 - Rhizomania resistant (French)	941003	5.3	6.2
FC712(4X)	FC 712 colchicine doubled	941006	5.7	6.2
	FC701/LSR-CTR - O-type mm	941038	5.3	6.2
	L599 - Rhizomania resistant (French)	941001	5.5	6.2
	L603 - Rhizomania resistant (French)	941002	5.8	6.3

¹Disease Index is based on a scale of 0 (=healthy) to 9 (=dead).

² $\alpha=0.05$.

Table 2. 1995 Cercospora Leaf Spot Nursery - Fort Collins, CO.

Source	Designation	Pedigree	Disease Index ¹		
			Date1 ²	Date2	Date3
		LSD ³	0.63	0.61	0.67
821051H2	LSRCK	Resistant Check	2.33	3.17	3.50
831085HO	FC708	released	2.67	3.17	3.67
911026HO	FC715	released	3.00	3.33	3.83
931007	FC720	C718/(C718/FC708), mm	2.83	3.50	4.17
811003HO	FC607	released	3.33	3.83	4.33
911028	FC716	released	3.00	3.83	4.33
941006	FC712(4X)	FC 712 colchicine doubled	3.00	3.67	4.33
921024	FC709-2	+ 2 cycles Rhizoc & 1 cycle sucrose	3.00	3.67	4.33
921022	FC702-7	+ 7 cycles Rhizoc	3.00	3.50	4.33
941005	FC710(4X)	FC710 colchicine doubled	3.17	3.83	4.33
921025	FC728	(A4 & D2 & 309)/FC708, MM	2.83	3.83	4.33
921002HO	FC604	released	3.00	3.67	4.50
921007	FC727	FC703/(AJ-ZZ & Aula Dei & 67-436), MM	3.00	4.00	4.50
921008	FC725	C37/FC707-2, MM	3.00	3.67	4.50
931005HO	FC721	Syn (FC701/LSR-CTR)//C718, mm	3.17	3.83	4.50
941038		FC701/LSR-CTR) O-type, mm	3.17	3.50	4.50
931010	FC726	FC703-5/Peramono, MM	2.83	3.50	4.50
94A076	FC609	released	3.33	3.50	4.67
911031	FC717	released	3.00	3.67	4.67
931005HO1	FC721CMS	C718CMS//Syn (FC701/LSR-CTR), CMS	3.00	3.83	4.67
921019	FC729	FC712/A4, 3 cycles Rhizoc, MM	3.17	4.33	4.83
931016HO		Highly inbred O-type	3.33	4.50	4.83
921021	FC703-5	+ 5 cycles Rhizoc	3.33	4.50	5.17
94A092		4918 (C918 sel) seg(Rz, A, R, Vy, Erw, PM, CT)	3.33	4.50	5.17
931016HO1		Highly inbred CMS	3.83	4.50	5.50
911037	FC719	released	3.50	4.33	5.50
911032	FC718	released	3.67	4.50	5.67
911043HO	FC403	released	4.17	5.83	6.00
941001H		L599 - Rhizomania resistant (French)	4.17	4.83	6.00
911043HO1	FC 403CMS	released	4.00	5.00	6.00
941001H2		L599 ms - Rhizomania resistant (French)	4.50	5.33	6.17
931002	LSSCK	Susceptible Check - (Leaf spot synthetic)	4.33	5.33	6.17
941003		L609 - Rhizomania resistant (French)	4.83	5.50	6.33
941002		L603 - Rhizomania resistant (French)	5.00	5.83	6.67
941004		L606 - Rhizomania resistant (French)	5.00	6.17	6.83

¹Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).

²Readings were taken on August 31, September 7, and September 14.

³ $\alpha=0.05$.

Table 3. 1995 Rhizoctonia Root Rot Nursery - Fort Collins, CO.

ENTRY	DJ ¹	%HLT ²	%HVST ³	Z%HLT ⁴	Z%HVST ⁴
	LSD*	0.80	14.918	15.348	
911037	FC719	released	1.34	63.98	100.00
831083	FC705/1	Highly Resistant Check	1.43	58.42	100.00
941005	FC710(4X)	FC710 colchicine doubled	1.48	58.26	100.00
921022	FC702-7	+ 7 cycles Rhizoc	1.47	62.08	98.89
921024	FC709-2	+ 2 cycles Rhizoc & 1 cycle sucrose	1.50	55.23	100.00
931010	FC726	FC703-5/Peramono, MM	1.54	50.18	100.00
941006	FC712(4X)	FC 712 colchicine doubled	1.49	60.83	98.57
911032	FC718	released	1.52	52.64	100.00
941038		FC701/LSR-CTR) O-type, mm	1.51	53.35	100.00
921025	FC728	(A4 & D2 & 309)/FC708, MM	1.57	51.08	100.00
831085HO	FC708	released	1.62	57.08	97.14
921021	FC703-5	+ 5 cycles Rhizoc	1.57	60.67	96.67
921008	FC725	C37/FC707-2, MM	1.59	61.31	98.82
921007	FC727	FC703/(AJ-ZZ & Aula Dei & 67-436), MM	1.71	40.93	100.00
931005HO1	FC721CMS	C718CMS//Syn (FC701/LSR-CTR), CMS	1.65	43.23	100.00
911026HO	FC715	released	1.72	37.65	100.00
931005HO	FC721	Syn (FC701/LSR-CTR)//C718, mm	1.70	45.49	98.82
921019	FC729	FC712/A4, 3 cycles Rhizoc, MM	1.76	47.22	96.00
911028	FC716	released	1.79	47.24	95.89
751080H	FC703	Resistant Check	1.79	44.07	97.71
911031	FC717	released	1.98	36.50	97.89
931016HO1		Highly inbred CMS - 52-305CMS (S ₁₂)	2.81	23.11	91.24
941001H		L599 - Rhizomania resistant (French)	2.94	17.77	83.26
942001 (Fargo)	FC907	Seed increase of screened multigerm (AF92-6)	3.00	11.28	89.65
911043HO	FC403	released	3.14	12.00	80.71

Table 3. 1995 Rhizoctonia Root Rot Nursery - Fort Collins, CO.

ENTRY		DI ¹	%HLT ²	%HVST ³	Z%HLT ⁴	Z%HVST ⁴
		LSD*			14.918	15.348
941001H2	L599 ms - Rhizomania resistant (French)	3.12	15.50	86.83	17.99	71.84
941003	L609 - Rhizomania resistant (French)	3.09	9.84	85.48	11.88	73.30
94A092	4918 (C918 sel) seg(Rz, A, R, Vy, Erw, PM, CT)	3.24	18.24	78.60	19.91	68.86
892008H2 (Fargo)	FC907	3.28	14.31	76.53	16.89	9.94
811003HO	FC607	3.34	8.00	78.67	10.05	68.39
931017	Susceptible Check - (FC901/C817)//413	3.41	7.06	83.92	9.82	69.71
AF92-1 (Fargo)	Oregon increase (straight)	3.59	10.00	73.78	9.00	2.49
94A021	released	3.59	12.92	72.10	16.33	61.19
941002	L603 - Rhizomania resistant (French)	3.75	8.41	69.56	13.15	62.75
921002HO	released	3.90	7.14	65.24	7.34	57.06
941004	L606 - Rhizomania resistant (French)	3.92	8.55	63.59	10.85	56.46
892009H2 (Fargo)	FC906	4.14	7.50	59.16	10.14	50.30
911043HO1	FC 403CMS	4.28	3.75	56.40	5.13	48.97
931016HO	Highly inbred O-type - 52-305 (S ₁₂)	4.46	1.82	58.40	3.51	53.01

¹Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).

²Percent of healthy roots (disease classes 0 and 1 combined).

³Percent of harvestable roots (disease classes 0 through 3 combined).

⁴Percentages were transformed to arcsin-square roots to normalize the data for analyses.

⁵ $\alpha=0.05$.

Table 4. 1995 Rhizomania Nursery - Salinas, CA (R. T. Lewellen - Test 6395).

Designation	Description	Visual evaluation for Rhizomania	Acre Yield		Beets/ 100'	Powdery Mildew ¹		CLS ²	RJAP ³
			Sugar lbs.	Beets Tons		Score	Score		
US H11	11-9-94	Susceptible	2334	11.13	10.54	166	2.0	4.6	72.7
R478	RZM R378, Y	Resistant (Rz)	5928	21.68	13.70	155	1.0	3.8	77.3
FC709-2	+ 2 cycles Rhizoc & 1 cycle sucrose	Susceptible (some resistant roots)	2552	9.92	12.89	155	2.6	3.5	74.8
L599	L599 - Rhizomania resistant (French)	Segregating for resistance	3681	15.96	11.50	158	2.1	4.6	73.2
L603	L603 - Rhizomania resistant (French)	Segregating for resistance	3825	14.68	12.94	145	1.6	5.1	74.8
L609	L609 - Rhizomania resistant (French)	Susceptible	2540	10.10	12.41	152	2.0	6.0	76.6
L606	L606 - Rhizomania resistant (French)	Segregating for resistance	2749	12.22	11.18	142	1.9	5.9	72.4
FC709	released	Susceptible (some resistant roots)	3161	12.54	12.70	153	2.8	3.4	74.1
Y139C7	RZM R039C6	Resistant (Quantitative)	5737	22.66	12.66	151	1.0	3.9	75.1
SP7622-0	Inc. SP6822-0 (8/87)	Susceptible	1929	8.95	10.75	148	2.0	3.0	73.8
R409	CR-RZM R209-#(C)	Segregating for resistance (Rz) ⁴	4901	18.77	13.07	141	1.3	3.3	77.3
R410	CR-RZM R210-#(C)	Segregating for resistance (Rz) ⁴	4812	19.30	12.54	145	1.5	3.4	74.2
Mean									
LSD ($\alpha=.05$)			3679.1	14.83	12.24	150.9	1.8	4.2	74.7
C.V. (%)			783.1	3.10	0.83	14.7	0.9	0.6	3.5
F value			21.4	21.00	6.80	9.8	51.4	15.2	4.7
			24.3**	18.90**	11.58**	2.0*	2.9**	21.1**	1.8ns

¹Powdery Mildew Score is based on a scale of 0 (=healthy) to 9 (=dead).

²CLS (Cercospora Leaf Spot) Score is based on a scale of 0 (=healthy) to 9 (=dead).

³RJAP = Raw juice apparent purity.

⁴R409, R410 are Leaf Spot Resistant from Italian sugarbeet germplasm.

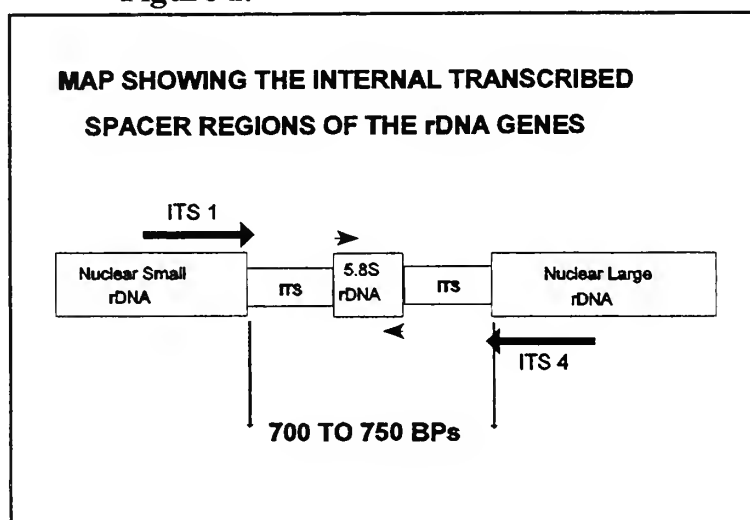
Genetic Variation and Pathogenicity in *Rhizoctonia Solani* - L. Panella and W. Zhang¹.

Currently, it is possible to assay the pathogenicity to sugarbeet of an isolate of *R. solani* through a greenhouse bioassay only, which may take 12 to 16 weeks. Although there has been recent work done on the phylogenetics of this pathogen, evolutionary relationships among isolates have not been well correlated with the host specificity of the fungus. Whether the pathogenicity to sugarbeet has evolved once or more than once in this fungus could substantially influence its interaction(s) with the sugarbeet plant.

R. solani is divided into anastomosis groups (AGs) based on the ability of the hyphae to fuse and exchange genetic material, or, more recently, into intraspecific groups (ISGs) based on molecular markers, especially the internal transcribed spacer (ITS) sequences flanking the 5.8S ribosomal RNA gene (rDNA). Isolates of *R. solani* from AG-4 cause seedling damping-off in sugarbeet, and isolates from AG-2-2 cause root and crown rot in mature beets.

The polymerase Chain Reaction (PCR) was used to amplify the DNA of *R. solani* coding for the 5.8S ribosomal RNA gene (rDNA) as well as the two flanking ITS regions. This was done with the ITS1 and ITS4 primers (Figure 1) (Lee & Taylor, 1990). Restriction enzymes that recognize four base-pair sites (Alu I, Hae III, Hha I, Hinf I, Hpa I, Rsa I) were used to create restriction fragment length polymorphisms (RFLPs) from the amplified DNA fragments. These RFLP markers were used to identify ISGs within AG-2-2.

Figure 1.



Isozyme markers from four enzyme systems (α - Acid phosphatase [α -ACP], Phosphoglucosmutase (PGM), Glucose-6-Phosphate-dehydrogenase (G6PDH), and Malate dehydrogenase (MDH)) are being used to further discriminate among isolates.

In collaboration with the USDA-ARS Plant Introduction Station at Griffin, GA, we are in the process of sequencing the DNA of the two ITS regions as well as the 5.8S rDNA gene. This is being done with a PCR reaction using the ITS-1 and ITS-4 primers, as well as primers on either side of the 5.8S rDNA gene (Figure 1). Hopefully, the sequence data will also provide the means to develop a quick molecular means to identify those isolates which are pathogenic to sugarbeet.

We are also testing the *Rhizoctonia* isolates for their pathogenicity to sugarbeet. The phylogenetic

¹Part-time BSDF employee and CSU graduate student.

information will be correlated with the pathogenicity data to see if all the isolates pathogenic to sugarbeet belong to the same evolutionary group. The sugarbeet-pathogenic group(s) will be delineated with genetic markers.

DNA from 92 isolates of *R. solani* was amplified and cut with the six restriction enzymes. RFLPs were detected with these enzymes. There were also, in some cases, initial differences in the size of the amplified length of DNA, which varied from approximately 700 to 750 base pairs. The DNA was separated on agarose gels, visualized with ethidium bromide, and photographed. The enlarged photographs were used to estimate the fragment sizes, by comparison with markers of known size (from a HaeIII digest of Φ X174RFI). Each isolate was scored for the presence/absence of all possible RFLPs generated by each restriction enzyme (5 to 10 RFLPs each). These data were analyzed and a phylogenetic tree was generated from this information. This tree did discriminate between AG-2-2 isolates and other AGs but did not give adequate discrimination within AG-2-2 or among the other AGs.

We have almost finished the isozyme analysis of 100 isolates and will be using those data in conjunction with the sequence data to determine the genetic relatedness of the different *Rhizoctonia* isolates to one another. We have complete sequence data from 70 of the isolates and hope to have the others finished soon (Table 5). These sequence data, with the isozyme data, will allow us to characterize the *Rhizoctonia* isolates.

The *R. solani* isolates have been tested for their virulence to sugarbeet seedlings. The Chi-square values (difference between the untreated control and the reaction of two sugarbeet lines to each isolate) will be used to classify the isolates based on their pathogenicity.

We will complete the isozyme and sequence analysis this summer. These data will allow us to determine the genetic relationships among the isolates of *Rhizoctonia*. Further greenhouse tests will be used to determine the pathogenicity of the isolates of *R. solani* to 8-week old sugarbeet roots. These data will be correlated with the phylogenetic information to fingerprint those isolates which are pathogenic to sugarbeet.

Lee, S.B., and J.W. Taylor. 1990. Isolation of DNA from fungal mycelia and single spores. Pages 282-287, in M.A. Innis, D.H. Gelfand, J.J. Sninsky and T.J. White (eds.), PCR Protocols: A Guide to Methods and Applications. Harcourt Brace Jovanovich, San Diego.

Table 5. The isolates of *Rhizoctonia solani* used in the genetic diversity study are listed with an identifying number; the code of the original donor; the source, AG designation, location where collected and any remarks from the donor; the donor's name.

Rhizoctonia Isolates in Genetic Diversity Test

R#	Code	Source/location/remarks	Received from
AG Testers from Akira Ogoshi			
1	CS-2	AG-1 IA	Earl Ruppel, CO
2	Shiba 2	AG-1 IB	Earl Ruppel, CO
3	BV-7	AG-1 IC	Earl Ruppel, CO
4	FC-2S	AG-2-1	Earl Ruppel, CO
5	C-116S	AG-2-2 IIIB	Earl Ruppel, CO
6	RI64S	AG-2-2 IV	Earl Ruppel, CO
7	ST11-6	AG-3	Earl Ruppel, CO
8	R101	AG-4 HG-I	Earl Ruppel, CO
9	ST 6-1	AG-5	Earl Ruppel, CO
10	IS1-1	AG-6 HG-I	Earl Ruppel, CO
11	1556	AG-7	Earl Ruppel, CO
12	TS2-4S	AG-BI (Bridging Isolate)	Earl Ruppel, CO
AG Testers from Carol Windels (originally from Neil Anderson)			
13	S-21	AG-9 (originally from Don Carling, Palmer, AK)	Earl Ruppel, CO
AG Tester from Steven Neate - Australia			
14	72	AG-8 (R-72 on slant); from clover roots, Conalbyn, Australia	Earl Ruppel, CO
Miscellaneous <i>Rhizoctonia</i> Isolates			
15	R-7	SB foliage, Willcox, AZ; by EGR (AG-4)	Earl Ruppel, CO
16	R-9	SB root, Colorado; orig. B-6 of Pierson & Gaskill (AG-2-2)	Earl Ruppel, CO
AG Testers from Carol Windels (originally from Neil Anderson)			
17	48	AG-2-1	Earl Ruppel, CO
18	H-3-77	AG-2-2	Earl Ruppel, CO
19	P42	AG-3	Earl Ruppel, CO

Table 5. The isolates of *Rhizoctonia solani* used in the genetic diversity study are listed with an identifying number; the code of the original donor; the source, AG designation, location where collected and any remarks from the donor; the donor's name.

Rhizoctonia Isolates in Genetic Diversity Test

R#	Code	Source/location/remarks	Received from
AG Testers from R. T. Sherwood			
20	S-284	AG-2-? from NC <i>Gypsophilla</i> stem (said to be "better" than W-22)	Earl Ruppel, CO
21	W-22	AG-2-2 from WI bean root (ATCC 18619)	Earl Ruppel, CO
22	W-24	AG-3 from WI potato stem (ATCC 14701)	Earl Ruppel, CO
Miscellaneous <i>Rhizoctonia</i> Isolates			
23	NBR-1	SB root, Imperial, NE, by EGR (AG-2-2)	Earl Ruppel, CO
24	R-1	SB root, Platteville, CO; by T. Antonopoulos for Gaskill ("A")(AG-2-2)	Earl Ruppel, CO
25	R-2	SB root, Platteville, CO; by T. Antonopoulos for Gaskill (AG-2-2)	Earl Ruppel, CO
26	R-4	SB root, Brighton, CO; by EGR (AG-2-2)	Earl Ruppel, CO
27	R-5	SB crown, Ft. Morgan, CO; by EGR (AG-4)	Earl Ruppel, CO
28	R-6	SB foliage, Swink, CO; by EGR (AG-4)	Earl Ruppel, CO
29	R-8	SB root, Willcox, AZ; by EGR (AG-2-2)	Earl Ruppel, CO
30	R-14	SB root, Wellington, CO; by EGR (AG-2-2)	Earl Ruppel, CO
31	R-239	From Mike Davis (Berkeley, CA); readily forms teleomorph stage (AG-4)	Earl Ruppel, CO
32	R-1411	From Lysle Leach; highly virulent on seedlings (AG-4?)	Earl Ruppel, CO
Isolates of AG-2-2 from Charlie Rush collected in Texas			
33	R1	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
34	R3	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
35	R4	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
36	R6	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
37	R8	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
38	R17	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
39	R19	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX

Table 5. The isolates of *Rhizoctonia solani* used in the genetic diversity study are listed with an identifying number; the code of the original donor; the source, AG designation, location where collected and any remarks from the donor; the donor's name.

Rhizoctonia Isolates in Genetic Diversity Test

R#	Code	Source/location/remarks	Received from
40	R27	AG2-2 (isolated from sugarbeet seedling)	Charlie Rush, TX
41	R33	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
42	R35	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
43	R36	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
44	R37	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
45	R86	AG2-2 (isolated from wheat)	Charlie Rush, TX
46	R98	AG2-2 (isolated from sugarbeet root)	Charlie Rush, TX
	Rhzc #	Isolates of AG-2-2 from Bill Bugbee in Fargo, ND	
47	2C1	Montana	Bill Bugbee, ND
48	5E13	Hollandale, MN	Bill Bugbee, ND
49	2A13	Montana	Bill Bugbee, ND
50	1A9	(on bran-soil) California (via Dr. Carling)	Bill Bugbee, ND
51	2C13	Montana	Bill Bugbee, ND
52	7A1	Ferry-Morse Seed Co. MN	Bill Bugbee, ND
53	5C5	MN (via Carol Windels)	Bill Bugbee, ND
54	7A5	Ferry-Morse Seed Co. MN	Bill Bugbee, ND
55	2E13	Montana	Bill Bugbee, ND
56	2C5	Montana	Bill Bugbee, ND
57	2E3	Montana	Bill Bugbee, ND
58	7A9	Ferry-Morse Seed Co. MN	Bill Bugbee, ND
Isolates of AG-2-2 from Leonard Herr at Ohio State University			
59	H502		Leonard Herr ,OH
60	H509		Leonard Herr ,OH
61	H549		Leonard Herr ,OH
62	H556		Leonard Herr ,OH
63	H581		Leonard Herr, OH

Table 5. The isolates of *Rhizoctonia solani* used in the genetic diversity study are listed with an identifying number; the code of the original donor; the source, AG designation, location where collected and any remarks from the donor; the donor's name.

Rhizoctonia Isolates in Genetic Diversity Test

R#	Code	Source/location/remarks	Received from
64	H582		Leonard Herr ,OH
65	H583		Leonard Herr ,OH
66	H585		Leonard Herr ,OH
67	H586		Leonard Herr ,OH
68	H589		Leonard Herr ,OH
Isolates Collected from Sugarbeets in Japan by Dr. Hirokatsu Uchino			
69	RH51	AG-4 Obihiro, Hokkaido, 1973 Damping-off	Dr. H. Uchino, Japan
70	RH52	AG-4 Obihiro, Hokkaido, 1973 Damping-off	H. Uchino, Japan
71	RH72	AG-1 Obihiro, Hokkaido, 1974 Damping-off	H. Uchino, Japan
72	RH74	AG-4 Makubetsu, Hokkaido, 1974 Damping-off	H. Uchino, Japan
73	RH105	AG-1 Makubetsu, Hokkaido, 1975 Damping-off	H. Uchino, Japan
74	RH107	AG-5 Bihoro, Hokkaido, 1975 Damping-off	H. Uchino, Japan
75	RH108	AG-1 Furano, Hokkaido, 1975 Damping-off	H. Uchino, Japan
76	RH109	AG-5 Furano, Hokkaido, 1975 Damping-off	H. Uchino, Japan
77	RH141	AG-4 Obihiro, Hokkaido, 1976 Damping-off	H. Uchino, Japan
78	RH147	AG-1 Obihiro, Hokkaido, 1976 Damping-off	H. Uchino, Japan
79	RH152	AG-4 Obihiro, Hokkaido, 1977 Damping-off	H. Uchino, Japan
80	RH26	AG-1 Obihiro, Hokkaido, 1971 Leaf blight	H. Uchino, Japan
81	RH88	AG-1 Obihiro, Hokkaido, 1974 Leaf blight	H. Uchino, Japan
82	RH89	AG-1 Makubetsu, Hokkaido, 1974 Leaf blight	H. Uchino, Japan
83	RH91	AG-4 Obihiro, Hokkaido, 1974 Leaf blight	H. Uchino, Japan
84	RH126	AG-1 Obihiro, Hokkaido, 1975 Leaf blight	H. Uchino, Japan
85	RH137	AG-1 Obihiro, Hokkaido, 1976 Leaf blight	H. Uchino, Japan
86	RH158	AG-1 Obihiro, Hokkaido, 1977 Leaf blight	H. Uchino, Japan
87	RH159	AG-1 Obihiro, Hokkaido, 1977 Leaf blight	H. Uchino, Japan
88	RH160	AG-1 Makubetsu, Hokkaido, 1977 Leaf blight	H. Uchino, Japan
89	RH193	AG-2-2 Obihiro, Hokkaido, 1990 Leaf blight	H. Uchino, Japan

Table 5. The isolates of *Rhizoctonia solani* used in the genetic diversity study are listed with an identifying number; the code of the original donor; the source, AG designation, location where collected and any remarks from the donor; the donor's name.

Rhizoctonia Isolates in Genetic Diversity Test			
R#	Code	Source/location/remarks	Received from
90	RH198	AG-2-2 Obihiro, Hokkaido, 1991 Leaf blight	H. Uchino, Japan
91	RH65	AG-2-2 Obihiro, Hokkaido, 1973 Root rot	H. Uchino, Japan
92	RH180	AG-2-2 Bihoro, Hokkaido, 1984 Root rot	H. Uchino, Japan
93	RH184	AG-2-2 Fukagawa, Hokkaido, 1986 Root rot	H. Uchino, Japan
94	RH188	AG-2-2 Otoe, Hokkaido, 1986 Root rot	H. Uchino, Japan
95	RH189	AG-2-2 Obihiro, Hokkaido, 1989 Root rot	H. Uchino, Japan
96	RH195	AG-2-2 Kamifurano, Hokkaido, 1991 Root rot	H. Uchino, Japan
97	RH196	AG-2-2 Furano, Hokkaido, 1991 Root rot	H. Uchino, Japan
Culture No. AG-2-2 from Carol Windels			
98	87-36-2	AG-2-2 from Pinto Bean; Trenton, ND	Carol Windels, MN
99	87-36-2	AG-2-2 from Pinto Bean; Trenton, ND	Carol Windels, MN
100	87-36-3	AG-2-2 from Pinto Bean; Trenton, ND	Carol Windels, MN
101	87-36-4	AG-2-2 from Pinto Bean; Trenton, ND	Carol Windels, MN
AG Testers from Carol Windels (originally from Neil Anderson)			
102	43	AG-1	Earl Ruppel, CO
103	140	AG-4	Earl Ruppel, CO
104	441	AG-5	Earl Ruppel, CO
AG Tester from Steven Neate - Australia			
105	182	AG-8 (R-182 on slant); from soil debris	Earl Ruppel, CO
AG Testers from R. T. Sherwood			
106	S-220	AG-1 from <i>Lotus</i> leaves; North Carolina	Earl Ruppel, CO
107	S-289	AG-4 from NC cotton hypocotyl	Earl Ruppel, CO

Test of Rhizoctonia Resistant Sugarbeet Germplasm Against Several Very Pathogenic Isolates of *Rhizoctonia solani* Ag-2-2 -- L. Panella, C. E. Windels¹, and E. G. Ruppel.

The breeding program at Fort Collins has been developing Rhizoctonia root rot resistant germplasm for over thirty years for release to the sugarbeet seed industry. This has been done in a field screening program in which an artificial epiphytotic has been created with a virulent isolate of *Rhizoctonia solani* from anastomosis group 2-2 (AG-2-2). This anastomosis group is variable and isolates exhibit varying degrees of pathogenicity on sugarbeets. Some very pathogenic isolates of *R. solani* Ag-2-2 were collected in Crookston, MN. We wanted to test whether they would overcome the resistance found in the germplasm released from the Fort Collins program and we wanted to test whether they were more virulent than the isolate that has been used to infest the Fort Collins Rhizoctonia root rot nursery.

Field trials were conducted at Crookston, MN and Fort Collins, CO, in which 4 isolates of *R. solani* collected in Minnesota (designated R98, R99, R100, and R101) and 1 isolate from Fort Collins (designated R9) were used to test the resistance of either 7 (in Fort Collins) or 9 (in Crookston) sugarbeet germplasms (Table 6).

Table 6. Germplasm evaluated for resistance to Rhizoctonia root rot in 1995 at Fort Collins and Crookston.

Germplasm	Description
ACH 306	Commercial variety with partial resistance to Rhizoctonia
ACH 194	Commercial variety susceptible to Rhizoctonia
Susceptible check	Fort Collins' germplasm - (FC901/C817)//413
FC705/1	Multigerm sib-line of FC705 - highly resistant check
FC708	O-type germplasm derived from SP63736-01 and PI260310
FC709-2	Multi-germ selection of FC709 sib-line
FC712	Selection from old open-pollinated sources
FC718	Intercross of 4 Russian germplasms
FC726	Multigerm germplasm - FC703/Peramono (Peramono is a fodder beet)

Sugarbeets were planted in one-row plots 56 cm (22 in) apart and 4.3 m (14 ft) long. The experiments were planted in mid-May and thinned to a 20- to 25-cm (8- to 10-in) in-row spacing. Sugarbeets (approximately 20) in each plot were hand inoculated with dry, ground, barley-grain inoculum as described earlier in this report. The field was managed to promote the disease as previously described. In September (Fort Collins) and October (Crookston) individual roots were

¹Plant Pathologist, Northwest Experiment Station, University of Minnesota, Crookston.

evaluated and scored on a scale of 0 (=healthy) to 7 (= plant dead) to calculate a plot mean disease index (DI). An analysis of variance was used to determine statistical differences (LSD separation, $\alpha = 0.05$) among isolates and germplasms, and to check for interactions between isolates and germplasms.

The disease indices calculated for each isolate of *Rhizoctonia* on the germplasms are illustrated in figures 2a and 2b. The disease was more severe in Minnesota by about 1 disease index grade. At both locations, the susceptible germplasms did significantly worse than the resistant and, at Minnesota, ACH 306 was intermediate.

There were significant interactions at both locations when the data were analyzed as a whole. These interactions could be explained by the varied reactions of the susceptible germplasms to the different *Rhizoctonia* isolates. When the resistant germplasms were analyzed without the susceptible germplasms, there were no interactions. These results are listed in Table 7.

Although there were differences among the resistant varieties, they all remained resistant when compared with the susceptible varieties. There was no "breakdown" of *Rhizoctonia* resistance to any of the virulent Minnesota isolates of *Rhizoctonia*. The isolate used in Fort Collins to test for resistance to *Rhizoctonia* was as virulent as any of the other isolates, regardless of which environment it was tested in.

There are no plans to continue this research any further at present.

Figure 2a

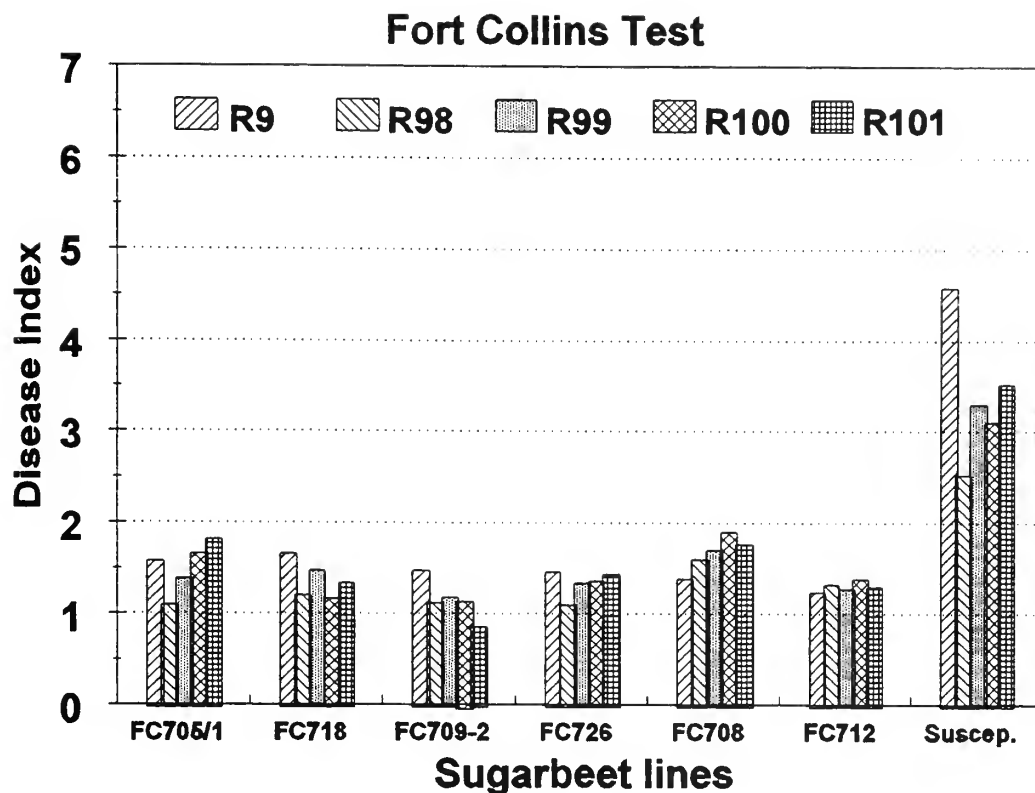


Figure 2b

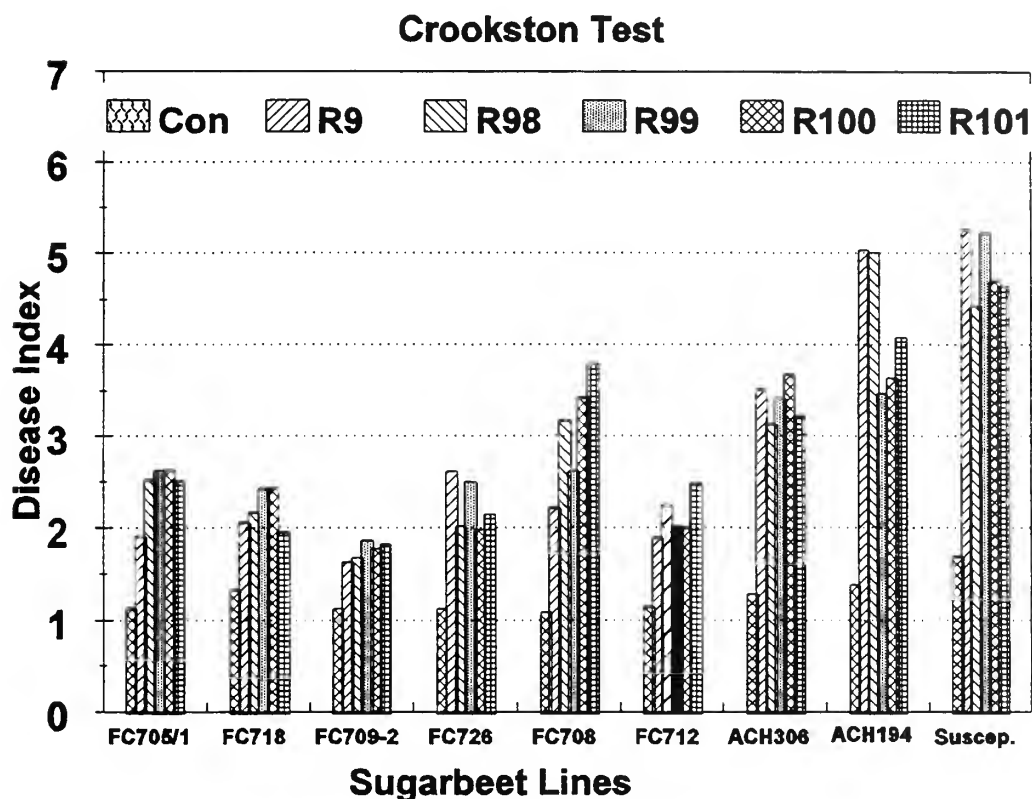


Figure 2. Disease Indices for resistant and susceptible sugarbeet germplasms inoculated with 5 different, virulent strains of *Rhizoctonia solani*, which causes Rhizoctonia root rot.

Table 7. Disease Indices for Rhizoctonia root rot resistant germplasm and pathogenic isolates of *Rhizoctonia solani* evaluated in field plots at Crookston, MN and Fort Collins, CO in 1995.

Resistant Germplasm ²	Disease Index ¹	
	Crookston	Fort Collins
ACH 306	3.4 a ³	— ⁴
FC708	3.0 a	1.7 a
FC705/1	2.4 b	1.5 a b
FC726	2.3 b	1.3 b c d
FC718	2.2 b	1.4 b c
FC712	2.1 b c	1.3 c d
FC709-2	1.8 c	1.2 d
<u>Rhizoctonia Isolate⁵</u>		
R9	2.3	1.5
R98	2.4	1.2
R99	2.5	1.4
R100	2.6	1.4
R101	2.6	1.4

¹Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).

²Each value is averaged across the 5 isolates of *R. solani*.

³LSD separation with $\alpha=0.05$.

⁴ACH 306 was not evaluated at Fort Collins.

⁵Each value is averaged across germplasms. Differences were not significant.

**CERCOSPORA LEAF SPOT RESEARCH AND BREEDING FOR
CERCOSPORA/CURLY TOP RESISTANCE
(BSDF Project 441)**

The Development of Sugarbeet Germplasm with Strong Resistance to Multiple Diseases, Especially *Cercospora* Leaf Spot and the Curly Top Virus. -- L. Panella and G. A. Smith¹

Increased resistance to *Cercospora* continues to be an extremely important goal. If the level of resistance available in most *Cercospora*-resistant experimental lines were present in commercial hybrids (along with good sugar and root yield), the need for fungicides would be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed, is evident by the occurrence of *Cercospora* strains that are resistant to our most potent fungicides. Additionally, some fungicides may be removed from the market because of their perceived or real threat to the environment. In many areas where *Cercospora* leaf spot is a problem, the curly top virus also causes significant losses. Additionally, there are some growing areas in which combined resistance to *Cercospora* leaf spot and *Rhizoctonia* root rot are desirable. Germplasm is needed with combined resistance to these diseases, along with good combining ability for yield components.

The objective of this program is the development, for release to the sugarbeet seed industry, of sugarbeet germplasm with strong resistance to multiple diseases, especially *Cercospora* leaf spot and the curly top virus. Lines will include monogerm CMS and O-type lines and multigerm pollinators. To achieve this objective, coordination of breeding effort will continue with geneticist Dr. Lee Panella who will direct the program from Ft. Collins.

A population from which to choose multigerm pollinators highly resistant to *Cercospora*, with good combining ability for agronomic traits is being developed. A cross among a highly *Cercospora*-resistant line (FC607 - ♀), a smooth root line from the USDA-ARS sugarbeet research group in East Lansing (SR87 - ♂), and commercial diploid hybrids developed by the defunct Great Western program (MonoHy A4, MonoHy T6, and MonoHy T7 - ♂s), was made in the greenhouse at Fort Collins, planted in the field in 1995, and the F₁ roots harvested this fall. They currently are being random mated in the greenhouse. F₂ seed will be planted in 1996. Individual F₂ mother roots will be selfed in Masonville, CO, taking advantage of pseudo self-fertility, and selfed seed used to progeny test for resistance to *Cercospora* leaf spot and to the curly top virus.

A monogerm population (F₂ seed of 2859 m (sp) aa/[FC607&FC604] and the reciprocal), segregating for *Cercospora* leaf spot and other disease resistances, self-fertility, and genetic male sterility, was grown in the field at Fort Collins in 1995. A multigerm-source population, segregating for *Cercospora* leaf spot resistance, other disease resistances, and self-fertility, was grown in the greenhouse at Fort Collins. Individual mother roots of the monogerm population from the field will be selfed in the greenhouse this winter (1995/1996) to provide seed for replicated progeny testing. The multigerm *Cercospora* leaf spot population was crossed to 4918aa (4918//R278 /FC902) from the USDA-ARS program in Salinas (further selection of C918) to introduce genetic male sterility and

¹Geneticist and Research Leader, USDA-ARS Northern Crop Science Lab, Fargo, ND

tolerance to the curly top virus. This population will be crossed to *Cercospora*-resistant selections from the multigerm population cross described above and used to produce germplasm with resistance to *Cercospora* and curly top.

Additionally, the *Cercospora* leaf spot-resistant, multigerm parent, FC907, is being crossed this winter with FC709-2, which is multigerm and has moderate *Cercospora* leaf spot and excellent *Rhizoctonia* root rot resistance. This population will produce multigerm germplasm with resistance to both diseases.

Twenty advanced breeding lines or *Cercospora*-resistant germplasms from Fargo were evaluated at the ARS leaf spot nursery at Ft. Collins (Table 8). These lines are part of the resistant germplasm development effort at Fargo and Fort Collins. The F₁ roots described above (four males - SR87, MonoHy A4, MonoHy T6, and MonoHy T7 - onto a highly *Cercospora*-resistant female - FC607, O-type) currently are being planted in the greenhouse for seed production. Individual plants of a monogerm population (F₂ seed of 2589aa/FC607&FC604 and the reciprocal), segregating for *Cercospora* leaf spot and other disease resistances, self-fertility, and genetic male sterility, are being selfed in the greenhouse. The multigerm *Cercospora* leaf spot population, 4918/R278/FC902, is being increased in the greenhouse. Plants from FC907, BC₄ and FC709-2 will be crossed in the greenhouse this winter. Hypocotyl color is being used as a marker to distinguish the hybrids.

The seed will be harvested from the F₁ roots (four males - SR87, MonoHy A4, MonoHy T6, and MonoHy T7 x *Cercospora*-resistant female - FC607, O-type). This will be planted at Fort Collins next year, and the resultant roots will be planted in Masonville the following year. Individual plants will be self-pollinated to take advantage of the pseudo self-fertility that is conditioned by this environment. Selfed seed from individual mother roots will be progeny tested. Remnant seed from the best-performing mother roots will be inter-crossed and crossed with the other two *Cercospora* resistant multigerm populations to produce populations of *Cercospora*-resistant multigerm pollinators. Seed from selfed monogerm plants will be progeny tested this year, and the most promising families will be recombined using remnant seed. Development of a resistant germplasm line generally takes 7 years. A longer time may be necessary to incorporate multiple disease resistances. In an established program, a "pipeline" of lines in various stages of development and evaluation is the norm. Hence, the release of new germplasm usually occurs every 2 to 4 years.

Table 8. 1995 Leaf Spot Evaluations - Germplasm from USDA-ARS at Fargo, ND.

Entry	Pedigree	Disease Index ¹		
		Date 1 ²	Date 2	Date 3
	LSD ³	0.50	0.55	0.60
LSRCK	Leaf Spot Resistant Check	3.17	3.33	3.83
871028HO3	FC607CMS/FC502-3, TO	2.83	3.00	4.00
892008H2	FC907, BC ₄	3.00	3.17	4.00
861016HO1	FC607(4X) C3	2.83	3.50	4.17
AF92-1	FC907 - Oregon increase (straight)	3.00	3.83	4.33
892010H2	FC607/H8277	3.00	3.33	4.33
892016H2	FC607 TO/Beta 207 (2X)	3.17	3.50	4.33
861016HO	FC607(4X) TO C3	3.00	3.67	4.33
942001	FC907 (Increase of screened Multigerm AF92-6)	3.33	3.50	4.33
841044HO2	FC607CMS/FC603 TO	3.17	3.50	4.33
871034HO5	761036HO1(CMS)/FC607 TO	3.00	3.50	4.33
892001H3	FC607CMS, MM/L19	3.00	3.83	4.50
892009H2	FC906, BC ₄	3.17	4.00	4.50
892017H	Beta 207 (2X)/FC607 TO	3.00	3.83	4.67
91N0009	F1012	3.67	4.33	5.00
91N0011	F1014	4.17	4.67	5.50
91N0007	F1010	4.00	4.50	5.50
91N0019	PI 181718	4.33	4.83	5.83
PI179180	PI 179180	4.17	4.67	5.83
LSSCK	Leaf Spot Susceptible Check	4.33	5.33	6.33
91N0010	F1013	4.17	5.00	6.33
91N0028H	F1011	4.17	5.17	6.33

¹Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).

²Readings were taken on August 31, September 7, and September 14.

³ $\alpha=0.05$.

WORLD BETA NETWORK (BSDF Project 442)

The 4th International *Beta* Genetic Resources Workshop and World *Beta* Network Conference was held February 28th through March 3rd, 1996 in Izmir, Turkey -- Lee Panella

Collections of primitive sugarbeet landraces, heritage sugarbeet varieties, other cultivated forms of beet (including chard), wild beets, and wild relatives of beets are important genetic resources for the sugarbeet breeder. Genes for disease resistance, stress resistance, and yield and quality components can be found in these plants and incorporated into commercial varieties. The World *Beta* Network (WBN) was founded by commercial and public researchers concerned about losses of these genetic resources and under-utilization of the collections containing these resources. It was organized in 1989 by the International Plant Genetic Resources Institute (IPGRI - formerly IBPGR) as an attempt to bring researchers, curators, and germplasm users from both developed and developing nations together to help manage and plan research to solve problems involving *Beta* genetic resources.

The 4th International *Beta* Genetic Resources Workshop and World *Beta* Network Conference was held February 28th through March 3rd, 1996 in Izmir, Turkey. The meeting was hosted by Drs. A. E. Firat and A. Tan of the Aegean Agricultural Research Institute in Izmir. The meeting was attended by 27 scientists representing 17 countries. There were three scientific sessions, which covered Biosystematics and taxonomy, Genetic diversity, and Genetic diversity and pre-breeding. The presentations were:

Biosystematics and Taxonomy

Characterization of wild beets in Turkey. - Dr. A. Tan.

Proposal for a new taxonomy of the cultivated beets. - Dr. W. Lange and Dr. W. Brandenburg.

Variation for developmental characters in *Beta vulgaris* ssp. *maritima* in relation to latitude: the importance of *in situ* conservation. - Prof. H. van Dijk.

Prospects for *in situ* conservation of beet populations in Turkey. - Dr. A. Tan.

Genetic Diversity

Genetic diversity of red table beets. - Prof. B. Michalic and Dr. D. Grzebelus.

Genetic diversity for male sterility in wild and cultivated beets. - Prof. N. O. Bosemark.

Collection of S-cytoplasm from various sources of sugarbeets. - Dr. A. V. Mglinets and Dr. S. G. Verprev.

Genetic Diversity and Pre-breeding

Genetic diversity for high temperature tolerance in sugarbeet. - Dr. H. M. Srivastava.

Screening and utilizing *Beta* genetic resources with resistance to *Rhizoctonia* root rot and *Cercospora* leaf spot in a sugar beet breeding program. - Dr. L. Panella.

Pre-breeding for major disease resistances in sugarbeets in Iran. - Dr. M. Nasser Arjmand et al.

Beta evaluation and sugarbeet enhancement from wild sources. - Dr. D. Doney

Additionally, 12 posters were presented. There was a lively and highly informative exchange of scientific information. On the Saturday following the meeting proper, there was a field trip to visit

wild *Beta vulgaris* ssp. *maritima* populations growing along the coast just north of Izmir. Funding for this meeting was provided by IPGRI, Italy; AGRA, Italy; Dieckmann-Heimburg, Germany; van der Have, the Netherlands; and Kleinwanzlebener Saatzucht AG (KWS), Germany. BSDF covered the costs of the tele-conferencing that was necessary to plan this meeting. Both the business and scientific proceedings of this meeting will be published by IPGRI.

The current Beta Coordinating Committee (BCC) of the WBN consists of the permanent secretary, Dr. Lothar Frese at the Institut für Pflanzenbau in Braunschweig, Germany; Dr. Michael Asher at IACR-Broom's Barn in the United Kingdom; Prof. Yi-Chu Sun at the Chinese Academy of Agricultural Sciences, Hulan County, China; and Dr. Lee Panella at the USDA-ARS Crops Research Laboratory in Fort Collins, USA. There are preliminary plans to have the next WBN meeting in Broom's Barn, UK in 1999. This is an exciting location with a strong emphasis on sugarbeet research and the screening of *Beta* germplasm. The BCC appreciates the continued support of the American sugarbeet research and user communities and the BSDF.

**EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO
RHIZOCTONIA SOLANI, A CAUSAL FUNGUS OF SUGARBEET ROOT ROT
(BSDF Project 903)**

1995 Evaluations of Contributor Lines for Reaction to *Rhizoctonia solani*--E. G. Ruppel.

We used randomized complete-block designs with five replications to evaluate a total of 138 lines from six companies; additionally, one company had a second test of 12 lines replicated three times. *Rhizoctonia*-resistant FC703 and highly susceptible FC901 were included as internal controls, along with highly resistant FC705-1. Experimental design, plot size, and evaluation method are described in the section "1995 Field Research on *Rhizoctonia* Root Rot of Sugarbeet." The experimental design, methods, results, and statistical analyses were provided to the appropriate company breeders or representatives.

Cold, wet weather after planting retarded plant growth and forced almost a 2-week delay in inoculation and evaluations. However, the hot, dry weather of late July and August provided ideal conditions for *Rhizoctonia* root rot, and an excellent epiphytotic developed in our nursery. Differences among entries in all tests were highly significant ($P < 0.0001$). Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and highly susceptible FC901 were 1.7, 2.1, and 4.3, respectively. Percentages of healthy roots (DIs 0 + 1/100) were 51.2, 36.9, and 8.0 for these controls, respectively. Percentages of roots in disease classes 0 thru 3 were 96.5, 94.9, and 58.2, respectively. The range of DIs for contributor lines was 0.9 to 6.6.

**EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO
CERCOSPORA BETICOLA, CAUSAL FUNGUS OF CERCOSPORA LEAF SPOT
(BSDF Project 904)**

1995 Evaluations of Contributor Lines for Reaction to *Cercospora beticola*--E. G. Ruppel.

We used randomized complete-block designs with three replications to evaluate 174 lines from three companies. Internal controls included a highly susceptible synthetic and a resistant check, FC(504 X 502/2) X SP6322-0. Two-row plots were 4.3 m (14- ft) long, with 56 cm (22 in) between rows and a 20- to 25-cm (8- to 10-in) within-row spacing. We inoculated twice (July 7 and 13); evaluations were made on August 31, September 7, and September 14.

Our 1995 leaf spot epidemic developed rather slowly due to a rain-delayed first inoculation and an unusually cool, wet spring and early summer. Higher temperatures in late July and August, coupled with our overhead irrigation to maintain high canopy humidity, induced a rapid increase in disease during the latter part of August. On September 14, means of the resistant and susceptible internal controls were 3.9 and 5.9 (scale of 0-10), respectively, across the nursery. In 1994 (September 2), these means were 3.3 and 4.8, respectively. Means of contributor lines on September 14 ranged from 3.8 to 7.2, compared with 3.0 to 5.8 in 1994.

SUGARBEET RESEARCH

1995 Report

SECTION D

Northern Crop Science Laboratory, Agricultural Research Service,
U.S. Department of Agriculture, Fargo, North Dakota

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University of Minnesota Northwest Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

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PUBLICATIONS

Abstracts of Papers Presented, Published or Approved for Publication

Bugbee, W. M. *Cercospora beticola* tolerant to triphenyltin hydroxide. *J. Sugar Beet Res.* (in press). 1996.

Three of five sugarbeet fields from two districts in Minnesota had unacceptable levels of *Cercospora* leaf spot after being sprayed with the maximum label amount of triphenyltin hydroxide (TPTH) in 1994. Strains of the fungus with varying levels of tolerance to TPTH were recovered from leaf spots. Mancozeb was effective against the tolerant strains. Strains with resistance to thiophanate methyl also were recovered.

Bugbee, W. M. *Cercospora beticola* strains from sugarbeet tolerant to triphenyltin hydroxide and resistant to thiophanate methyl. *Plant Disease* 80:103. 1996.

Strains of *Cercospora beticola*, which cause leaf spot on sugarbeet (*Beta vulgaris* L.), developed resistance (growth rate comparable to controls) to benzimidazole-type systemic fungicides in the 1970s. The replacement protective fungicide was triphenyltin hydroxide (TPTH). A decrease of disease control with TPTH in 1994 in Minnesota prompted a 1995 survey to estimate the prevalence and distribution of possible tin-tolerant strains (slower growth rate compared to controls). Using a micropipette, conidia from single leaf spots were suspended in 3 μ l of water and aliquoted to each of four culture dishes containing potato-dextrose agar amended with 0.2, 1.0 TPTH or 5 μ g ml⁻¹ of the systemic fungicide thiophanate methyl (TM), or unamended. Occasionally, colonies from conidia from the same leaf spot grew on both 1 μ g ml⁻¹ TPTH and 5 μ g ml⁻¹ TM. Three to six hyphal-tip cultures were established from each of 12 colonies that exhibited resistance to TM and tolerance to TPTH. All of the hyphal-tip colonies (61) grew on 1 μ g ml⁻¹ TPTH with mean linear growth that was inhibited 64%, compared to the control colonies and on 5 μ g ml⁻¹ TM with mean linear growth that was inhibited 4%, compared to the control colonies. Of 41 isolates that were sensitive to both fungicides, mean linear growth was inhibited 10% on 1 μ g ml⁻¹ TPTH and 100% on 5 μ g ml⁻¹ TM. Measures to control leaf spot with these fungicides should proceed with caution in light of this finding of cross resistance in *C. beticola*.

Bugbee, W. M., C. A. Wozniak and G. A. Smith. A two-way approach to improve root rot resistance. *J. Sugar Beet Res.* 32:131. 1995.

Pectin lyase, produced by *Rhizoctonia solani*, was found associated with crown and root rot on sugarbeet. The sugarbeet also was found to produce a pectin lyase inhibitor protein (PNLIP). The behavior of PNLIP in controlled experiments prompted efforts to pursue the goal of manipulating PNLIP for enhanced root rot resistance. Polyclonal and monoclonal antibodies to PNLIP were used to probe sugarbeet cDNA libraries. Transformed *E. coli* colonies were lifted with nitrocellulose membranes, lysed directly on the membranes and probed with antibodies. The monoclonals appeared to be more specific than the polyclonals. Colonies whose lysates reacted positively with monoclonals were electrophoresed and the protein bands were electroblotted to nitrocellulose. None of these fractionated bands reacted with the monoclonals. Nine amino acids at the amino terminal of PNLIP were sequenced. Two oligonucleotides were synthesized based on the amino acid sequence and will be used in further efforts to isolate the PNLIP-encoding ELISA protocol to estimate the PNLIP content in small samples of sugarbeet extract. Plants with high or low levels of PNLIP were cloned by apical meristem culture. Clones were interpollinated to create four synthetic lines. In a small greenhouse trial, the effect of this selection technique was not conclusive.

Campbell, L. G. and G. A. Smith. The association of *Cercospora* resistance and yield in commercial hybrids. *J. Sugar Beet Res.* 32:131. 1995.

Incorporating disease resistance while maintaining or increasing yield and quality is a constant challenge for plant breeders. This task is more difficult if the disease is not simply inherited, such as *Cercospora* leaf spot (*Cercospora beticola*) of sugarbeet (*Beta vulgaris*). This study examines the trade-off between *Cercospora* resistance and performance. Forty hybrids, all recommended for *Cercospora*-threat areas, were grown at Fargo, North Dakota (no *Cercospora*) and at Ft. Collins, Colorado (inoculated with *Cercospora*) in 1991 and 1992. Disease severity (0 = none to 9 = severe) was recorded at Ft. Collins. Root yield was measured at both locations. Regression analysis indicated that Fargo root yields increased 1.1 ton/acre for each increment of increased susceptibility. A 1.3 ton/acre decrease for each increment of susceptibility indicated that under the severe epidemic at Ft. Collins in 1991 *Cercospora* resistance provided substantial protection. Under a moderate epidemic in 1992 there was no apparent relationship between yield and resistance at Ft. Collins, suggesting that the benefits of resistance were similar to the yield potential sacrificed to obtain the resistance.

Doney, D. L. and R. J. Hecker. USDA-ARS sugarbeet releases. *J. Sugar Beet Res.* 32:136. 1995. (Also, Doney, D. L., *J. Sugar Beet Res.*, in press).

It wasn't until the 1920's that the USDA became significantly involved in sugarbeet breeding. Early efforts were located at Salt Lake City, UT and Riverside, CA. Additional stations were added at Salinas, CA; Beltsville, MD; Ft. Collins, CO; East Lansing, MI; and Fargo, ND. Since then, the breeding programs at the Riverside, Salt Lake City, and Beltsville stations have been closed. The first USDA releases were developed for curly top resistance. Since then, breeding responsibilities among USDA breeders have been for sugarbeet diseases and pests. Additional efforts have focused on breeding methods, bolting resistance, cytoplasmic male sterility, O-type maintainers, sugar and root yield, smooth roots, and integration of wild germplasm. The development of monogerm and cytoplasmic male sterile lines by USDA breeders are landmark achievements for the industry and are of world wide importance. Early releases were for direct commercial use; however, recent efforts have been for parental lines and/or enhanced germplasm. Prior to 1955, releases were shared with the industry with little public documentation. From 1956 to 1970, releases were through the Beet Sugar Development Foundation (BSDF). Since 1971, an official USDA-ARS release document has been issued and signed by all involved agencies. Most releases have been registered in *Crop Science*, seed deposited in the National Seed Storage Laboratory at Ft. Collins, CO and documented in the GRIN database. A listing of all releases (over 800), along with codes, citations and limited descriptions has been prepared. While it is difficult to quantify the impact USDA/ARS sugarbeet releases have had on industry, it is obvious that they are a major factor in the survival and stability of the sugarbeet industry.

Smith, G. A. Biological warfare against a serious sugarbeet pest. *Sugar J.* 3:21-23. 1995.

Biological control of sugarbeet pests, primarily sugarbeet root maggot, is the primary goal of the Sugarbeet Research Unit at the Northern Crop Science Laboratory. The finding and development of biological agents has become a necessity because toxic residues of insecticides are being found in the soil and in the farm products, attributed to the use of chemical insecticides on widely planted crops. New rules of the Environmental Protection Agency have outlawed or threatened to outlaw many chemical insecticides farmers have relied upon. Also, the use of perfected biological control methods is expected to be less expensive than the use of toxic chemicals. Scientists are studying naturally occurring biological agents to combat the sugarbeet root maggot. The sugarbeet root maggot is known to cause damage throughout two-thirds of the U.S. beet growing area.

Smith, Garry A. ARS researchers discover another potential biopesticide: Biological project explores parasite. *Sugar Producer* March 1996:14-17. 1996.

Currently the ARS team at the Northern Crop Science Laboratory in Fargo, ND is working with three species of fungi: *Beauveria bassiana*--the white muscardine fungus, *Metarhizium anisoplae*--the green muscardine fungus, and an as yet unnamed species. Both of the muscardine fungi have been previously demonstrated to function as efficient biopesticides in a variety of crop/pest situations and are being commercially produced on an ever increasing scale. The latter agent appears to be a new species not previously described and is the first known natural pathogen of the sugarbeet root maggot.

Smith, G. A. and L. G. Campbell. Association between *Cercospora* resistance and yield in commercial sugarbeet hybrids. *Plant Breeding* (in press). 1996.

This report documents the difficulty breeders have experienced in combining resistance to *Cercospora* leaf spot (causal agent: *Cercospora beticola* Sacc.) with high yield in sugarbeet (*Beta vulgaris* L.). Forty commercial hybrids, all recommended for *Cercospora*-threat areas, were grown in a *Cercospora*-free and a diseased (inoculated) environment in 1991 and 1992. A 2.9 Mg ha⁻¹ decrease in root yield associated with each increment increase in susceptibility confirmed that under a severe epiphytotic (1991) *Cercospora* resistance provided substantial protection. Under less severe disease conditions (1992) there was no apparent relationship between yield and resistance, suggesting the benefits of resistance were similar to the yield potential sacrificed to obtain the resistance. In the absence of the disease, root yields increased 2.7 Mg ha⁻¹ for each increment of increased susceptibility. There was no evidence of association between sucrose concentration and resistance in the *Cercospora*-free environment. In spite of the limited success in developing resistant hybrids, the demonstrated ability of *Cercospora* to produce fungicide-resistant strains and the possibility that effective fungicides will not be available are arguments for continued breeding efforts.

Smith, G. A. and J. D. Eide. Biological control of the sugarbeet root maggot via pathogenic fungi. Proc. 28th Biennial Meeting, Amer. Soc. Sugar Beet Technol., p. 167-169. 1995.

Entomopathogenic (insect disease causing) fungi are unique among insect pathogens because they infect by penetrating the external cuticle instead of the gut. We are investigating the entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae* for pathogenicity and virulence to the root maggot. These two fungi are not obligate pathogens and are soil borne. Based on studies with laboratory animals, neither species is considered infective or toxic to humans. We have found that both of these fungi infect and kill at several insect

developmental stages, including the adult fly. We have found infection in eggs, second instar, third instar and adults. Infection and mortalities for the important third instar stage of the insect after seven days exposure was about 15 per cent for both fungi. But after 15 days and beyond, infection by *Beauveria* resulted in 30-46 per cent mortality and infection by *Metharhizium* resulted in 94-100 per cent mortality.

Smith, G. A. and J. D. Eide. Defense protein synthesis in response to *Cercospora beticola*. Proc. 58th Congress of the International Institute for Beet Research, p. 165-172. 1995.

Resistance to *Cercospora beticola* in sugarbeet has been an ongoing challenge to sugarbeet breeders because *Cercospora* is a world wide disease. Control of resistance to this disease is quantitative and characterized by low heritability. Genetic resistance has been developed and breeding lines with high levels of resistance are available. However, resistant cultivars frequently do not yield as well as less resistant cultivars under nondisease conditions. Data presented will expand on this relationship. Recent research relating to the biochemical host/pathogen association involving phytoalexins, chitinase, and glucanase also will be discussed.

Wozniak, C. A. Nutrition and mediation of larval development of the sugarbeet root maggot by bacteria. J. Sugar Beet Res. 32:165. 1995.

Tetanops myopaeformis Roder, the sugarbeet root maggot (SBRM), maintains an internal population of gut-associated microbes. Identification of these insect-endogenous bacteria on selective and non-selective media from third instar larvae at four geographic locations and on root feeding sites resulted in a total of 53 species characterized. Isolation of bacteria from the sugarbeet rhizoplane in the absence of SBRM, revealed a subset of eight species common to both SBRM and sugarbeet roots. *Stenotrophomonas maltophilia* was the only species ubiquitously encountered from all sources tested. Surface disinfestation of SBRM eggs yielded gnotobiotic larvae which were co-cultured with axenic sugarbeet cells. First instars were observed to feed on cells growing on plant culture medium, but moulted to the second instar at low levels; no third instars were produced. Addition of *S. maltophilia* inoculum provided for development to the third and final instar. Three other species, *E. coli* JM109, *Serratia liquefaciens*, and *Pseudomonas syringae* pv. *aptata*, were also found capable of supplying a moulting factor which resulted in enhanced larval development. Amendment of gnotobiotic cultures with cell-free culture filtrate of *S. maltophilia* resulted in the production of third instar SBRM also, indicating the presence of a soluble factor needed for development. Consumption of sugarbeet tissues was facilitated by the presence of bacteria.

Wozniak, C. A. and Hinz, S. E. *Stenotrophomonas maltophilia*: An endosymbiont of the sugarbeet root maggot, *Tetanops myopaeformis* (Diptera: Otitidae), and a rhizospheric commensal of sugarbeet. *Am. Soc. Microbiol. Abstr.*, p. 333, Annual Meeting, Washington, D.C. 1995.

Third-instar larvae of the sugarbeet root maggot (SBRM) collected from four geographic regions were surface disinfested, homogenized and aerobic heterotrophs isolated on selective and non-selective media for identification of native microflora. Rhizoplane washings of field grown sugarbeet taproots were plated in dilution series for bacterial isolation. *S. maltophilia* was the only ubiquitously encountered aerobic heterotroph of the 53 eubacterial species identified. Following an assessment of antibiotic resistance, a highly selective medium was developed for isolation of *S. maltophilia* from complex samples. Rhizosphere- and SBRM- derived isolates were compared to the type strain, ATCC 13637, *Serratia liquefaciens*, *Pseudomonas syringae* 'aptata', and *Escherichia coli* JM109 for their abilities to provide for SBRM development when co-cultured with gnotobiotic larvae and axenic sugarbeet suspension culture cells. All bacterial species were capable of providing a 'moulting factor' for SBRM development, however, *S. maltophilia* isolates were superior in % moults obtained (*i.e.*, > 45% of larvae reached final instar). A 0.2 μ m filtrate of *S. maltophilia* broth culture was also capable of providing for larval moulting. In the absence of added bacteria, SBRM gnotobiotics failed to grow or develop to the third instar. In co-cultures amended with bacteria, utilization of sugarbeet tissues was greatly enhanced compared to non-bacterial controls. None of the environmental or clinical isolates yielded a hypersensitive response or disease symptoms when inoculated into tobacco or sugarbeet leaves. Analysis of outer membrane proteins via SDS-PAGE indicated that isolates could be grouped in part by strain origin.

Papers Published Since Abstracted in Previous Report(s)

Campbell, L. G. Long-term yield patterns of sugarbeet in Minnesota and eastern North Dakota. *J. Sugar Beet Res.* 32:9-22. 1995.

Doney, D. L. Registration of y317, y318, y322, and y387 sugarbeet germplasms. *Crop Sci.* 35:947. 1995.

Doney, D. L. International activities in *Beta* germplasm. In R. R. Duncan (ed.), *International Germplasm Transfer: Past and Present*. Chapter 14:177-185. 1995.

Doney, D. L., B. Ford-Lloyd, L. Frese, and A. Tan. Scientists worldwide rally to rescue the native beets of the Mediterranean. *Diversity* 11:124-125. 1995.

CERCOSPORA LEAF SPOT RESEARCH AND BIOPESTICIDE RESEARCH

BSDF Project 601

G. A. Smith

Breeding for Cercospora Leaf Spot Resistance

G. A. Smith, L. G. Campbell and L. A. Panella

Seed of a new breeding line designated 'FC 907' is currently being increased pending release by the agency in late 1996. This line is intended for use as a component of commercial hybrids and its release comes at a time when *Cercospora* is becoming a major problem in several major growing areas. This line is exceptionally resistant to *Cercospora beticola*. In field tests over the last three years, it has been equal to the resistant check (see Project 441, Panella and Smith). It is a multigerm line which also has a degree of resistance to Rhizoctonia root and crown rot. *Cercospora* strains resistant to triphenyltin fungicides were identified in growing areas and are causing great concern to the industry, making the release of this new germplasm very timely. Seed is being increased in the greenhouse at Fargo and will be planted for increase in Oregon in August 1996. Limited quantities from the greenhouse increase should be available in late summer 1996 and larger quantities available in 1997 from the field increase.

Molecular Basis for Cercospora Resistance

G. A. Smith and J. D. Eide

The molecular basis for *Cercospora* resistance is being studied. The pathogenesis related (PR) proteins chitinase and glucanase have been isolated from leaf spot resistant (LSR) sugarbeet leaves by ammonium sulfate precipitation and chitin affinity chromatography. The apparent molecular weight of chitinase and glucanase as determined by SDS-polyacrylamide gel electrophoresis was 34 kD and 26 to 29 kD, respectively. Glucanase isolated by affinity chromatography had an isoelectric point of 4.9. The specific activity of the fraction before chromatography was 8 μMol reducing sugar $\text{min}^{-1} \text{mg}^{-1}$ protein and the fraction eluted off the column had a specific activity of 142 μMol reducing sugar $\text{min}^{-1} \text{mg}^{-1}$ protein. Proteins with these molecular weights and/or activities *have not been previously reported* and may be linked to *Cercospora beticola* field resistance.

Glucanase was separated by SDS-PAGE and transblotted to polyvinylidene difluoride in preparation for N-terminal amino acid sequencing. The N-terminal amino acid sequence of a 26 kD glucanase isolated from LSR sugarbeet leaves was determined to be: Thr Thr Phe Thr Val Val Asn Asn Cys Gln. Glucanase samples were lyophilized in preparation for antibody production.

Four chitinase primers were synthesized for use in PCR detection of acidic chitinases in LSR and wild type sugarbeet germplasm. The sequence of the primers is as follows: 5' ACAAATTGTAACAGTCTGAGCAGT 3', 5' GAAGATCTGGTTAGCTTGACTGT 3', 5' TAGTGCGGTTGATCCTAAGT 3' and 5' AAGATTATCACCAGGAGCAAC 3'.

Biopesticide Laboratory Work

G. A. Smith and J. D. Eide

The biological control agents *Beauveria bassiana* and *Metarhizium anisopliae* are being tested as a biocontrol agent against the sugarbeet root maggot (SBRM). Overwintering viability is being examined for *B. bassiana* and *M. anisopliae*. The entomopathogenic fungi *B. bassiana* and *M. anisopliae* were viable after 21 months of freezer storage at -20° and -80° C (Table 1). Cultures overwintered in the field and were viable six months after application. A method for rapid production of the biopesticide *Metarhizium anisopliae* was formulated. Barley soaked in 1% potato dextrose broth for 1 hour, drained and autoclaved for 30 minutes provided a good growth medium. Flasks inoculated with *M. anisopliae* produced conidia within 3 to 4 weeks.

Biopesticide Field Studies

G. A. Smith, L. G. Campbell and J. D. Eide

Field testing of *M. anisopliae* and *B. bassiana* was carried out at St. Thomas and Hillsboro, North Dakota. The fungal treatments consisted of fall, spring or spring plus fall applications at Hillsboro, North Dakota (Table 2). The St. Thomas treatment consisted of spring only treatments. The application methods consisted of in-furrow at planting, broadcast and spray application at peak fly activity. Results are presented in Figure 1. Lorsban treated plots were significantly lower in damage than other treatments, although spring plus fall applications of fungi tended to reduce damage.

Table 1. Viability of freezer-stored *B. bassiana* and *M. anisopliae* (+ = still viable, nd = not determined).

Fungus Tested and Temperature		Months						
		2	4	5	6	7	8	21
<i>M. anisopliae</i>	@-20° C	nd	nd	+	+	+	+	+
"	@-80° C	nd	nd	+	+	+	+	+
<i>B. bassiana</i>	@-20° C	nd	nd	+	+	+	+	+
"	@-80° C	nd	nd	+	+	+	+	+

Table 2. Summary of fall and spring applied fungal treatments, Hillsboro, North Dakota, 1995.

Treatment		Spring	Fall
<i>B. bassiana</i>	(B-Fall)	-	Broadcast once
<i>B. bassiana</i>	(B-Spr1)	Broadcast once	-
<i>B. bassiana</i>	(B-Spr2)	Broadcast twice + banded at peak fly activity	-
<i>B. bassiana</i>	(B-Fall+S)	Broadcast once	Broadcast once
<i>M. anisopliae</i>	(M-Fall)	-	Broadcast once
<i>M. anisopliae</i>	(M-Spr1)	Broadcast once	-
<i>M. anisopliae</i>	(M-Spr2)	Broadcast twice + banded at peak fly activity	-
<i>M. anisopliae</i>	(M-Fall+Spr)	Broadcast once	Broadcast once
Lorsban	(Lors)	Banded at planting	-
No Treatment	(Cont)	-	-

*All treatments had fungal infected barley applied in furrow at planting

Yield data at Hillsboro suggest the fall plus spring treatments yielded significantly greater than the controls. This suggests that specific combinations of treatments and field rotation may be important in biopesticide activity.

We collected dead maggots from the field plots. Both *M. anisopliae* and *B. bassiana* were isolated from these maggots.

A soil-crusting problem at St. Thomas resulted in no significant differences in yield between the control and Lorsban. Other comparisons are not valid without good controls.

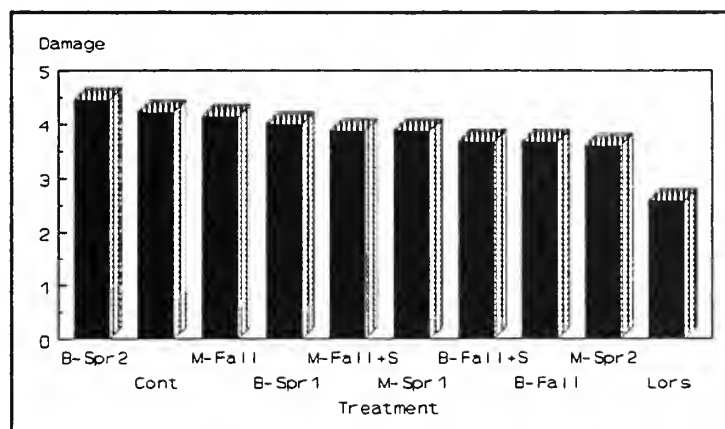


Figure 1 Sugarbeet root maggot damage on specified sugarbeet plots with fall and spring applied combinations, Hillsboro, North Dakota, 1995. See Table 2 for a description of the treatments presented in this figure.

We have begun a three-year field trial at the Crookston Experiment Station to determine the establishment of these bio-control fungi under standard crop rotation practices.

RHIZOCTONIA ROOT ROT RESEARCH

BSDF Project 610

W. M. Bugbee

Using a Sugarbeet Enzyme Inhibitor to Screen for Resistance to Rhizoctonia Root Rot

The purification and partial characterization of pectin lyase, an important disease-related enzyme from *Rhizoctonia solani*, was previously reported. Also, we reported the partial purification and characterization of a proteinaceous inhibitor of pectin lyase called a pectin lyase inhibitor protein (PNLIP) that was produced by the sugarbeet. Our working hypothesis was that the PNLIP gene can be manipulated to over-produce PNLIP and thereby increase resistance to root rot by deactivating the pectin lyase that is produced by *R. solani*. Antibodies to PNLIP have been used to probe for the PNLIP-encoding sugarbeet gene in several strains of *Escherichia coli* that had been transformed with sugarbeet DNA, but with no success. Therefore, a second approach was initiated using a reverse transcriptase PCR protocol. Two oligonucleotides were purchased from National Biosciences, Inc. The oligos were based on the first nine amino acid sequence at the amino terminal of the PNLIP protein. These oligos were used as primers in a PCR reaction to generate multiple copies of sugarbeet cDNA. The reverse transcriptase method and sugarbeet mRNA was used to generate the template cDNA. The cDNA has been made, stored, and is ready for ligation into plasmids.

Using Antibodies of PNLIP to Select Plants with High Levels of PNLIP

This project was initiated about three years ago. The objective was to select young plants with high levels of PNLIP, to clone the selections and to produce synthetic lines under the theory that these lines would have an enhanced level of resistance to *R. solani*. A few microliters of sugarbeet extract were reacted with antibodies against PNLIP using the enzyme-linked immunosorbent assay (ELISA). Plants with the highest levels of PNLIP were selected, cloned from axillary meristems, and crossed to make synthetic lines. These lines were tested in 1995 in the Ft. Collins root rot nursery for their reaction to *R. solani*. The results were poor. The selected lines performed no better than the susceptible controls. The approach failed probably because the PNLIP represents only a portion of the sugarbeet's total defense arsenal; therefore, plants with high levels of the inhibitor are not necessarily resistant. The following approach to produce synthetic lines with root rot resistance should be more successful than the antibody approach because the plants are inoculated. Obviously, the response of an inoculated sugarbeet represents the entire defense mechanism and not just a portion of it.

The Fastest Way to Screen For Rhizoctonia Root Rot Resistance - To Date

Unpublished data at this location shows that if a sugarbeet is resistant to *R. solani*, this resistance is not evident under greenhouse conditions until the plants are about five weeks old. Therefore, this greenhouse trial was performed to see how many five-week-old plants could be inoculated per house and how long it would take to make a determination of the reaction to *R. solani*. Plants were thinned to one per four-inch pot about three weeks after planting and inoculated at five weeks after planting by placing two Rhizoc-laden barley kernels at one site, against the root about 0.5-inch below the soil line. The greenhouse temperature was 75 to 80°F. The lesions on the stem were examined two weeks later by simply pulling the soil away from the inoculation site, and the plants were classified as susceptible or resistant based on the reaction of known resistant germplasm line FC 712 and the susceptible cultivar Ultramono. The germplasm lines used in this trial were FC712, F1010, P510 and Ultramono.

Results

The resistant control, FC 712, and the susceptible control, Ultramono, gave the expected reactions two weeks after inoculation. All of the 70 Ultramono plants had susceptible lesions and some were wilted. Twelve of the 60 plants of FC 712 were saved and placed in photothermal induction because the lesions were absent or very small. In addition to these control plants, a total of 1,333 plants were evaluated, selections were made, and selected plants were placed in photothermal induction.

This trial showed that an evaluation for *Rhizoctonia* resistance can be made in the greenhouse by 48 days after planting (DAP) the seed. The inoculation was done at 35 DAP and evaluated at 47 DAP. Some obvious evaluations were based on a few plants that were wilted two weeks after inoculation, but most evaluations were based on the lesion size that was evident on the upper root of the inoculated plants.

The selected plants were soil-drenched with about 250 ml of Benlate (benomyl) at 1500 ppm before being placed in the photo-thermal induction room. This treatment was done to kill any *R. solani* that might be surviving in the soil. It is presumed that active Rhizoc inoculum could cause root rot on a resistance-suppressed bolting plant after it has been returned to the greenhouse bench. The selected plants were returned to the greenhouse for seed production after 100 days in the photo-thermal induction room and 147 days after planting the seed.

A SURVEY FOR THE PREVALENCE AND DISTRIBUTION OF *CERCOSPORA BETICOLA* TOLERANT TO TRIPHENYLTIN HYDROXIDE AND RESISTANT TO THIOPHANATE METHYL IN MINNESOTA AND NORTH DAKOTA -- 1995
BSDF Project 611

W. M. Bugbee

This survey was supported, in part, by the Sugar Beet Research and Education Board of Minnesota and North Dakota and the Griffen Corporation, Valdosta, GA.

Triphenyltin fungicides (hydroxide, chloride or acetate) have been very effective against *Cercospora beticola* L. for the control of leaf spot on sugarbeet. Triphenyltin hydroxide (TPTH) is superior to copper and carbamate fungicides in toxicity and persistence on leaves and has been used extensively in the Northern Plains of the United States, where *Cercospora* leaf spot is a problem. TPTH usage increased dramatically after the rapid development of strains that became resistant to the benzimidazole class of fungicides in the early 1980's in Minnesota and North Dakota. TPTH now is the primary fungicide for the control of *Cercospora* leaf spot on sugarbeets.

Strains of *C. beticola* tolerant to triphenyltin have been reported from Greece, Italy and the former Yugoslavia. Since 1986, field isolates of *C. beticola* have been tested in our laboratory for tolerance to TPTH with negative results. In 1994, there were fields in west-central and southern Minnesota where control of *Cercospora* leaf spot was not as complete as in the past. When we transferred conidia of *C. beticola* from leaf spots to media containing TPTH, the amount of growth indicated that the fungus had acquired tolerance to the fungicide. Because of this finding, it was decided to survey the sugarbeet growing regions of Minnesota and North Dakota in 1995 for the prevalence and distribution of strains of *C. beticola* with tolerance to TPTH as well as resistance to benzimidazole-type fungicides represented by thiophanate methyl (TM).

Materials and Methods

A request was made to American Crystal Sugar Co. and Minn-Dak Farmers Cooperative to collect five to ten leaves with leaf spot from 25 randomly selected fields within each of their districts and to send these leaves to the USDA-ARS Northern Crop Science Laboratory at Fargo. The Southern Minnesota Beet Sugar Cooperative was asked to send samples from 50 fields because of their history of greater leaf spot pressure than the more northern districts. When the leaves arrived they were spread out on a greenhouse bench to dry and thus preserve the spores within the leaf spots. Spores from leaf spots were assayed for sensitivity to TPTH and TM as follows:

Technical grade TPTH, (97.1% a.i) or TM (95.7% a.i.) was dissolved in acetone and added to potato-dextrose agar (PDA) after the PDA was autoclaved and cooled to 55°C. Acetone alone was added to PDA controls. Lids were kept off poured culture plates for 30 min to allow dissipation of acetone in a sterile, laminar-flow transfer hood. Antibiotics were added to 55°C PDA after autoclaving to retard bacterial growth in all culture media that received conidia directly from leaf spots (streptomycin sulfate 300 ppm and carbenicillin 50 ppm).

Conidia of *C. beticola* were transferred from leaf spots to culture media with the aid of a dissecting microscope and a micropipette. The micropipette tip was loaded with 3 μ l of sterile distilled water. The water contained a trace of bromophenol blue so that the inoculation sites on the agar medium could be seen and tracked. The colorant did not interfere with germination of the conidia and dissipated from the agar within 24 hours. Conidia were dislodged from an individual leaf spot with the water and taken up into the micropipette tip and then aliquoted to each of four 10-cm square culture dishes. Twenty-five sites per dish could be inoculated without crowding. The culture dishes contained PDA or PDA plus 0.2 or 1 ppm TPTH or 5 ppm thiophanate methyl. Therefore, samples of conidia from a single leaf spot were evaluated for their response to TPTH and TM simultaneously. The cultures were incubated at 22°C and evaluated for growth four to six days later.

Results and Discussion

Colony formations of at least 2-mm diameter on TPTH or TM amended agar four to six days after the spores were transferred was the criterion for growth. The large number of samples did not permit the measurement of colony diameter. But, based on experience, estimates were that colonies on TPTH were inhibited 40 to 70% when compared to colonies on the unamended agar and that colonies on TM were inhibited 0 to 10% compared to the unamended agar. In those cases where colonies were just visible to the naked eye after four to six days of incubation, they were rated at 0+ to indicate the spores had germinated and the fungus had grown very slowly. These occurrences were mainly from the northern-most districts.

Leaf samples and spores from leaf spots from the southern Minnesota district had the highest frequency of colonies that grew on 0.2 or 1 ppm TPTH and 5 ppm TM (Tables 1 and 2). This should not be a surprise, since the environment in southern Minnesota is more conducive to *Cercospora* leaf spot development than in the Red River Valley. More fungicide is applied in that district and the more a fungus is exposed to a fungicide, the greater are the chances that the fungus will adapt to the fungicide if, in fact, it will adapt at all. The development of strains of *Cercospora* resistant to the benzimidazole fungicides also began in the southern Minnesota district for the same reasons. It should be emphasized that benzimidazole-type fungicides have not been used for several years, yet strains of the fungus that are resistant to this type of fungicide are still present, which indicates that benzimidazole-resistant strains will persist for years once they develop.

The district with the next highest frequency of tolerant or resistant strains was Minn-Dak, followed by a sharp drop in frequency for the remaining districts. Again, the distribution of tolerant and resistant strains could be due to the frequency of exposure of the fungus to the

fungicide. As we move north from the southern-most area, leaf spot pressure decreases along with spray frequencies and, therefore, the duration of exposure of the fungus to the fungicide. For this reason, the decreased frequency of tolerant strains of *Cercospora* in the north compared to southern regions should be expected. The behavior of the fungus has followed a well established principle in plant pathology that says, "the probability of a fungus adapting to a fungicide increase with exposure to the fungicide".

Table 1. Summary results of a survey of growers' sugarbeet fields in Minnesota and North Dakota for sensitivity of *Cercospora beticola* to triphenyltin hydroxide (TPTH) and thiophanate methyl (TM). (Excluding fungicide trials)

Factory District	Leaves Submitted	Leaf spots Transferred	Percent of total leaf spots that yielded <i>Cercospora</i> cultures ^a		
			0.2 ppm TPTH	1 ppm TPTH	5 ppm TM
			%	%	%
Drayton	157	689	2	0	2
East Grand Forks	191	522	2	1	0
Crookston	220	926	0.4	0	0
Hillsboro	50	117	0	0	0
Moorhead	306	890	2	1	1
Wahpeton	215	798	31	13	8
Renville	360	1684	60	42	17
Total	1499	5626			

^a Cultures were evaluated 4 to 6 days after incubation at 23°C. Growth was considered positive if the colony was at least 2 mm in diameter.

Table 2. Summary of leaf samples tested which yielded *Cercospora* growth on three fungicide concentrations.

Factory District	Samples Submitted	Percent of total leaf spots that yielded <i>Cercospora</i> cultures ^a		
		0.2 ppm TPTH	1 ppm TPTH	5 ppm TM
		%	%	%
Drayton	30	1	0	3
East Grand Forks	29	7	7	0
Crookston	22	9	0	0
Hillsboro	24	0	0	0
Moorhead	39	18	15	3
Wahpeton	34	82	68	35
Renville	52	96	93	72
Total	230			

^a Cultures were evaluated 4 to 6 days after incubation at 23°C. Growth was considered positive if the colony was at least 2 mm in diameter.

**BROADENING THE GENETIC BASE OF SUGARBEET
(PRE-BREEDING)
*BSDF Project 630***

Devon L. Doney

Most sugarbeet breeders are concerned about the narrow genetic base of sugarbeet breeding pools. Even though progress is still being made, continued improvement into the next century is dependent on the infusion of new and/or additional genetic variation. The most likely source is from untapped wild germplasm. Generations of severe stress has resulted in wild types with genes unlike those in our domesticated cultivars.

The major objective of this research is to develop near-sugarbeet type populations containing new genetic variation that can be incorporated into elite sugarbeet breeding pools. Secondary objectives include the development of effective selection criteria.

New Releases

Hybrids of germplasms y317, y318, y322, and y387, that were released to industry in 1994, were tested in replicated field trials in 1995 (Table 1). The results were similar to yield trials conducted in 1993 (Sugarbeet Research 1993, p. D19-D20). Hybrids of y322 and y387 gave root yields equal to the mean of the two commercial hybrids included in this test. Hybrids of all the releases were lower in sucrose percentage than the commercial hybrids.

All four germplasms have been crossed to a sugarbeet inbred with high combining ability for sucrose percentage. The first segregating populations were space-planted in a selection trial in the summer of 1995. Individual roots were selected based on specific gravity. Progeny of these selections will be evaluated in the field in 1996.

Fifty separate family lines from cross L53cms X *B. maritima* (a mixture of many accessions), which had been selected for sugarbeet like root shape for three successive cycles, were crossed to the sugarbeet inbred L33cms. The 50 family lines were selected from population x111, which was tested in 1992 and found to have potential as new near-sugarbeet type germplasm.

Table 1. Root yield, sugar percentage, and sugar yield for hybrids of releases y317, y318, y322, and y387 and the mean of two commercial hybrids.

Entry	Root Yield (T/A)	Sugar (%)	Sugar Yield (Lbs/A)
L33cms X y317	21.8	11.2	4845
L33cms X y318	19.9	10.4	4577
L33cms X y322	26.8	11.0	5886
L33cms X y387	25.3	10.5	5326
Hybrid Checks	26.9	11.7	6322
LSD 0.05	2.7	0.5	671

New Populations:

Seven populations, derived from crosses between a sugarbeet line segregating for genetic male sterility and regional mixtures of *B. maritima* or other subspecies of *B. vulgaris*, advanced through two cycles of random intercrossing and two cycles of selection for early emergence and early leaf initiation, were grown in a trial for root shape selection. Approximately 140 of 1200 roots (12%) were selected from each population. Selected roots within each of the seven populations will be intercrossed to constitute the next generation for root shape selection.

The above seven populations also were crossed to sugarbeet inbred L33cms and tested in a replicated field trial in 1995 (Table 2). These tests were conducted to evaluate the potential of the various sources of wild germplasm, even though these populations have very sprangled roots and are far from being acceptable sugarbeet germplasm. The crosses yielded higher than expected, compared to the commercial hybrids, and most exhibited some hybrid vigor. Population A13, derived from a cross between *B. atriplicifolia* and the sugarbeet inbred, showed the most promise (Table 2). All populations were low in sugar, suggesting that selection for root shape also should be accompanied by selection for sugar percentage.

The best sugar percentage was found in population A17, which contained wild *B. maritima* germplasm from Ireland. Population A4 was a mixture of *B. maritima* germplasm that had been selected through five generations for enlargement of the root and decreased sprangling. Even though this population contained no known sugarbeet genes, it gave a respectable yield. Population A5 was derived from a cross between L53cms and a mixture of *B. maritima* accessions that had been selected for root shape for five cycles. It shows potential as near-sugarbeet type germplasm.

Table 2. Root yield, sugar percentage, and sugar yield for 9 populations and the mean of two commercial sugarbeet hybrids.

Entry	Description	Root Yield (T/A)		Sugar (%)		Sugar Yield (Lbs/A)	
		Pop.	Hybrid	Pop.	Hybrid	Pop.	Hybrid
A4	<i>B. maritima</i> (mixture)	23.6	22.3	8.4	10.6	3958	4703
A5	L53cms X <i>B. maritima</i>	18.3	26.6	9.1	11.0	3297	5583
A8	3747ms X <i>B. maritima</i> (Denmark)	15.7	19.5	10.8	11.0	3415	4303
A13	3747ms X <i>B. atriplicifolia</i>	20.4	25.2	10.1	10.3	4128	5168
A15	3747ms X <i>B. maritima</i> (Belgium)	18.3	20.5	10.5	10.5	3822	4320
A17	3747ms X <i>B. maritima</i> (Ireland)	18.2	19.8	11.5	12.0	4166	4750
A19	3747ms X <i>B. patula</i>	19.0	20.0	10.2	11.5	3901	4506
A20	3747ms X <i>B. maritima</i> (annuals)	21.1	20.2	9.8	10.1	4114	4074
A22	3747ms X <i>B. macrocarpa</i>	18.5	21.0	10.5	10.5	3771	4410
Check	Commercial Hybrids		26.1		12.8		6068
LSD 0.05			4.5		0.7		654

New Crosses

Forty new populations are in the early developmental stage. These were produced from crosses between a self incompatible sugarbeet inbred and 40 *B. maritima* accessions from the North Atlantic. The populations were generated by 1) crossing 10 plants from each accession to the self-incompatible sugarbeet inbred, 2) intercrossing 10 plants from each of the 10 F₁ plants (total 100 plants) to generate the F₂ seed, and 3) bulking equal numbers of seed from each of the F₂ plants to generate the F₃ seed. Fourteen hundred plants from each F₃ bulked seed lot will be used to select for early germination and early first leaf initiation. Selected plants will be intercrossed to produce the initial root shape selection generation. This method was used to insure that the genetic variation existing within each accession was represented in the first selection generation.

Selection: First Leaf Initiation

Earlier studies have suggested that the initiation of the first leaf can be altered genetically and that leaf initiation is influenced by both additive and non-additive genetic variation. Preliminary field studies suggested that genetic changes in leaf initiation can have effects on root yield and plant growth. A field trial was conducted this past year to evaluate the influence changes in leaf initiation have on sugar production.

This test (Table 3) was to evaluate the effects of early leaf initiation (IN) using mass selection for population improvement and combining ability for hybrid development. All selections were made in population i32 (a very heterogenous population). For comparison purposes, i32, the hybrid of i32 X L53cms, and two commonly used commercial hybrids were included in the test. Populations y225 (fast leaf initiation) and y246 (slow leaf initiation) were derived through mass selection. Populations developed via combining ability (CA) analyses were z6 (fast leaf initiation) and z5 (slow leaf initiation). These four populations along with the hybrids of the combining ability populations, using L53cms as the female parent, were included in the test.

All three hybrids (z5 X L53cms, z6 X L53cms and i32 X L53cms) exhibited heterosis for root yield and sucrose percentage. However, there were no differences between the selection populations (z5 and z6) or the selections and the parent population (i32); nor were there differences among their hybrids (Table 3). The fast leaf initiation population (y225) gave a higher but non-significant root yield than the slow leaf initiation population (y246). These data do not support earlier studies in which the fast leaf initiation selection yielded more than the slow leaf initiation selections.

Table 3. Root yield, sucrose percentage, and total sucrose yield of selections for fast and slow first leaf initiation (IN), the parent population, and the mean of two commercial hybrids.

Entry	Selection Criteria	Root Yield (T/A)		Sucrose (%)		Sucrose Yield (Lbs/A)	
		Pop.	Hybrid	Pop.	Hybrid	Pop.	Hybrid
z6	CA for fast IN	23.3	25.2	10.5	11.4	4818	5745
z5	CA for slow IN	24.5	25.5	10.2	11.0	4984	5580
i32	Parent	23.8	24.6	10.5	11.7	4990	5742
y225	fast IN		25.0		10.3		5174
y246	slow IN	24.1		10.3		4966	
Commercial Hybrids			26.7		12.2		6484
LSD 0.05			3.4		0.6		732

Selection: Stress

We have been evaluating this selection procedure for the past several years. This past year's field trial was conducted to evaluate the effects of selections made for stress under outside conditions vs. selections made for stress under growth chamber conditions. Population B26 was an intercross of the best plants under stress and population B28 was an intercross of the poorest plants under stress. Both populations, along with the parent population (x130) and two commercial hybrids, were planted in a replicated field trial (Table 4). The best (under stress) population yielded more but not significantly more than either the poor (under stress) population or the parent. Even though the yields were in the same direction as earlier tests, the influence appears to be small.

Table 4. Root yield, sucrose percentage, and total sucrose yield for two stress selection populations, the parent population and the mean of two commercial hybrids.

Entry	Selection Criteria	Root Yield (T/A)	Sucrose (%)	Sucrose Yield (Lbs/A)
B26	Best under Stress	25.6	10.7	5470
B28	Poorest under Stress	24.6	9.7	4770
x130	Parent	23.6	10.4	4910
LSD 0.05		3.0	0.6	802

Selection: Leaf Initiation vs. Stress

This test was conducted to evaluate the multiple effects of selection for early leaf initiation and stress survival on root yield and to compare the two methods of selection. Individual plants of a highly heterozygous population were crossed to inbred L53cms. At harvest, each plant was trimmed of its seed stalk and returned to the cold room. Seed of each cross was planted in controlled growth chambers and each cross ranked in relation to early first leaf initiation and stress survival. Based on these results, three groups were selected: 1) those that survived best under stress conditions, 2) those with the earliest leaf initiation, and 3) a combination of the two. The resulting progenies from each of the three groups were crossed to inbred L53cms and tested in a replicated field trial along with the respective open-pollinated populations (Table 5).

Since this was a true recurrent selection method, the means of the hybrids should reflect the effects of selection. The selection for leaf initiation gave the best yield, however, it was not significantly superior. It appears that some combining ability was lost when the two selection parameters were combined.

Table 5. Root yield, sucrose percentage, and total sucrose yield of the recurrent selection populations for stress survival, early leaf initiation, and stress survival-early leaf initiation and the hybrids of these populations.

Entry	Selection Criteria	Root Yield (T/A)		Sucrose (%)		Sucrose Yield (Lbs/A)	
		Pop.	Hybrid	Pop.	Hybrid	Pop.	Hybrid
A1	Stress survival-Early leaf initiation	23.5	23.8	8.5	9.9	4091	4705
A2	Stress survival	21.7	25.5	9.6	10.3	4177	5227
A3	Early leaf initiation	22.6	26.8	9.0	10.0	4058	5332
Commercial Hybrids			25.3		11.3		5716
LSD 0.05			3.4		0.6		705

BIOLOGICAL CONTROL OF THE SUGARBEET ROOT MAGGOT

BSDF Project 641

Chris A. Wozniak

Genetically-Engineered Rhizospheric Microbes of Sugarbeet in the Management of Sugarbeet Root Maggot Damage

Stenotrophomonas maltophilia is the primary target of our transformation efforts due to its ecological niche as a symbiont and commensal microbe in the sugarbeet root maggot (SBRM) and rhizosphere of sugarbeet, respectively. As the only bacterium consistently found as a member of the larval microflora, this organism was determined to be capable of supporting larval development in an *in vitro* co-culture system utilizing gnotobiotic SBRM first instars. Additionally, *S. maltophilia* was commonly associated with the sugarbeet rhizoplane, as well as with the roots of other crop plants.

Although this organism is ubiquitous in the environment and has been the subject of some epidemiological studies, little information has been published regarding the basic genetics of this bacterium. Attempts to genetically engineer this species are absent from published literature even though *S. maltophilia* has been deployed for biocontrol of a turfgrass leaf blight and damping-off disease of container grown plants. As the only member of a newly erected genus the properties of this bacterium are proving to be unusual, but of great potential for a variety of agricultural and industrial uses.

The initial focus of this project was the screening of over 125 strains collected from the sugarbeet rhizosphere, internal SBRM tissues and clinical samples for the presence of naturally occurring, stably maintained episomal replicons. Using standard alkaline lysis procedures for plasmid isolation and a modified protease-SDS lysis procedure (CAW, unpublished), these isolates were prepared for separation of small to medium sized plasmids on a standard agarose gel. Following electrophoresis and ethidium bromide staining of the gels, it was determined that only three strains contained an extrachromosomal episome, all of low copy number. Upon subculturing of these strains, it was noted that the plasmids were not maintained. This most likely reflects the absence of the proper selective agent (*i.e.*, antibiotic) required to maintain the replicon during cell division.

Without the benefit of a known selectable marker for these strains that is expressed on a suitable plasmid (*i.e.*, a positive control), it is problematic to provide the appropriate culture conditions for maintenance and selection. An antibiotic resistance profile was prepared for these strains using the Kirby-Bauer disc-diffusion method on Mueller-Hinton medium; of the commonly available antibiotics, only tetracycline and kanamycin demonstrated antibiosis, and this with only a few strains. Resistance to the majority of compounds precluded many commonly used vectors due to the lack of selectability.

A derivative of plasmid pJP4, which is known to replicate in a variety of gram negative bacteria, was obtained from Dr. Alan Harker of Brigham Young University. This plasmid, pRO101, carries markers for tetracycline (Tc^r) and mercury (Hg^r) resistance and had been reported to replicate in a naturally occurring, uncharacterized isolate of *S. maltophilia*. Testing of sugarbeet rhizospheric strains for susceptibility to Hg indicated that a high level of natural tolerance/resistance to this heavy metal existed. Hence, this marker was not suitable for selection of transformants, even at 25 µg/ml. Tetracycline, however, was able to inhibit growth of a small number of strains at elevated levels (e.g., 50 µg/ml). These strains were then used for transformation experiments mediated by a combination of DMSO, polyethylene glycol 8000, and Mg⁺⁺ (TSS solution), as described for *E. coli*.

Although the three plasmids tested (pUC18, pBI121, pRO101) all indicated successful introduction and replication in *E. coli* JM109, none of these replicons appeared to be maintained in *S. maltophilia*. This could either be due to lack of incorporation into the cell or incompatibility of the replicon within these strains. To provide evidence of the mechanism interfering with transformation, triparental matings were performed using *S. maltophilia* ATCC 13637 (recipient), *E. coli* MM294/pRK2013 (*mob*⁺) and *Alcaligenes eutrophus* pRO101(donor). Although initial selections yielded colonies upon Tc^r selective medium, subcultures indicated that the origin of replication on pRO101 was not suitable for maintenance in this chromosomal background. Similar results were obtained using a trimethoprim (Tp^r) resistance marker contained on pSUP*Tn*5TpMCS. Contrary to published studies indicating susceptibility to this class of antibiotics within clinical strains of *S. maltophilia*, all of the rhizospheric isolates grew well on Tp at 50 µg/ml.

To enhance the probability of obtaining transformants, we have recently purchased an electro-cell manipulator for transfection of cells with electroporation technology. Using *E. coli* as an internal standard, conditions were defined which yielded increased numbers of transformants with plasmids listed above. Recently we have been able to introduce pRO101 to the type strain of *S. maltophilia* (ATCC 13637) via electroporation and subsequent selection on Tc. Following analysis of this plasmid's stability in ATCC 13637, we will introduce it into larval and rhizospheric strains; regulatory contacts have already been established with USDA/APHIS and EPA Biopesticide Division to obtain approval for future testing.

In cooperation with Dr. Margaret Pooler, USDA/ARS, Beltsville, MD, a small plasmid (1.4 kbp) from *Xylella fastidiosa* (pXf1), cloned into pGEM and pALTER and transformed into *E. coli* DH5α, will be assessed for its ability to replicate in *S. maltophilia*. This plasmid is known to have significant homology with *S. maltophilia* at the DNA sequence level and may provide the proper origin of replication needed for maintenance. Evaluation of this and any other plasmids discovered from ongoing screening will enhance the probability of finding the most suitable vector for genetic modification of this potential biopesticide.

SUGARBEET RESEARCH

1995 Report

Section E

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION

Halloin, J. M., Bugbee, W. M., and Theurer, J. C. Biological control of crown and root rot of sugarbeets caused by *Rhizoctonia solani* in a disease nursery. In: European Journal of Plant Pathology, Abstracts of the XIII International Plant Protection Congress. 7/2 - 7/7/95, The Hague, the Netherlands. Abstract #595.

A disease nursery used for more than 20 years in evaluation of resistance of sugarbeets (*Beta vulgaris* L.) to crown and root rots caused by *Rhizoctonia solani* (AG 2-2) in recent years has failed to produce disease suitably severe to discriminate resistant from partially resistant germplasms. The nursery employs a two year rotation between sugarbeets and alfalfa (*Medicago sativa* L.); and annually the sugarbeets are inoculated six weeks after planting, by dispensing into their crowns, millet caryopses on which the fungus has been grown. Experiments were done to determine if biological control of the pathogen was responsible for low disease severity. Highly susceptible to highly resistant sugarbeet genotypes were planted in the established nursery and in an adjacent field with no prior history as a root rot disease nursery. In two of three years, the disease was more severe at the new sites than in the established nursery. Inoculated plants at the new sites also were more stunted. Biological control of *Rhizoctonia* seems a likely cause of the decreased disease severity in the established nursery. However, microbiological assays of soil from the sites revealed no consistent differences in populations of fungi, fluorescent *Pseudomonas* spp., or actinomycetes. Isolates of actinomycetes and *Trichoderma* spp. inhibitory to *R. solani* have been obtained from the soil samples, but their role in the apparent biological control is unclear.

Halloin, J. M., and Elliger, C. A. Characterization, localization and toxicity of phenolic phytoalexins associated with crown and root rot lesions caused by *Rhizoctonia solani* in sugarbeets. In: Program and Abstracts of the International Symposium on *Rhizoctonia*. 6/27 - 6/30/95, Noordwijkerhout, the Netherlands. (Abstract No. P-3-10) p.53.

The phenolic phytoalexins betagarin and betavulgarin occur in association with foliar lesions of sugarbeets (*Beta vulgaris* L.) caused by *Cercospora beticola*. We studied phytoalexins associated with disease lesions caused by *Rhizoctonia solani* (AG 2-2) on crowns and roots of sugarbeets. Infected tissues contained betagarin and betavulgarin, as well as two new compounds that are a glucoside and a xyloside of betavulgarin. Only trace amounts of these compounds were isolated from healthy tissues surrounding disease lesions. Growth of *R. solani* on agar media containing these phytoalexins revealed that only betavulgarin caused inhibition of radial growth of the fungus. Chemical assays showed that agar medium containing

betavulgarin, on which the fungus had grown, contained noninhibitory betavulgarin glycosides, demonstrating that the fungus detoxifies the phytoalexin via glycosylation. Diseased tissues fail to accumulate betavulgarin at concentrations that are highly inhibitory to the fungus, apparently due to this detoxification. We propose that glycosylative detoxification of phenolic phytoalexins may be of widespread occurrence in plants infected by *R. solani*.

Halloin, J. M. and Roberts, D. L. Temperature as a determining factor in storage rot of sugar beets caused by *Aspergillus fumigatus*. J. Sugar Beet Res. 32:59-67. 1995.

Aspergillus fumigatus was a pathogen in sugar beet roots held at temperatures of 35°C or greater. The fungus occurred as a surface contaminant on freshly harvested roots; it increased in incidence during storage of roots at 6°C, apparently infecting wounds, but caused no rot at the lower temperature. A cultivar resistant to crown and root rot caused by *Rhizoctonia solani* (AG-2-2) was more tolerant to *A. fumigatus* than a *R. solani*-susceptible cultivar at 35°C, but this tolerance diminished with an increase in temperature to 40°C. Roots killed by freezing were rotted rapidly at 22°C, suggesting that tolerance to the rot is more likely due to inducible rather than to constitutive inhibition of the fungus. Development of rot coincided with maximum growth of the fungus at about 40°C. Rot caused by *A. fumigatus* is likely to be a problem only in stored roots that have undergone composting or metabolic heating. Subsequent cooling of such roots is unlikely to control further rot development.

Tsai, C.J. and J.W. Saunders. Growth regulator and genotype effects on somatic embryogenesis from sugarbeet callus. Proceeding, 1995. Congress on In Vitro Biology, Denver, CO. May 20-24. P. 59A.

Opaque white somatic embryos up to 4 mm long were elicited from hormone autonomous sugarbeet (*Beta vulgaris* L.) Callus within 5 weeks following plating of fresh suspension cultures grown on hormone free MS medium onto further hormone free MS medium. Suspension cultures had been initiated from approximately one month old leaf disc callus formed on MS + 1.0 mg/l 6-benzyladenine. The inclusion of 0.1 - 0.3 mg/l abscisic acid in the plate out medium significantly increased the production of somatic embryos. Maximum average somatic embryo yield observed was 77 per ml of suspension plated out (minimum size for counting, 0.5 mm). Most somatic embryos developed into plantlets, often with betalain pigmentation on hypocotyls, after transfer onto hormone free MS medium. Genotype strongly influenced yield of somatic embryos.

Tsai, C.J. and J.W. Saunders. Somatic embryos from callus of sugarbeet biotechnology clone REL-1. Accepted, J. Sugar Beet Research.

Somatic embryos could be used for proliferative propagation or for gene transfer procedures in sugarbeet (*Beta vulgaris* L.) if adequate methods for initiation could be devised. With sugarbeet model clone REL-1, plating of fresh suspension culture cells grown with hormone-free Murashige and Skoog (MS) medium onto further hormone-free MS medium elicited a low frequency of somatic embryogenesis, about one embryo per ml of suspension used. The inclusion of 0.1 or 0.3 mg/L abscisic acid (ABA) in the plating medium increased the number of somatic embryos in this system. A combination of 1 mg/L naphthaleneacetic acid (NAA) and 0.1 mg/L ABA gave the highest somatic embryo yield, 15 embryos per ml of suspension. After 22 to 40 days, embryos at various stages, ranging from globular, heart and torpedo-shaped to mature opaque white embryos with cotyledons and radicles, were present at the callus surface. The external morphology of several somatic embryos was examined by scanning electron microscopy. The somatic embryos developed into normal plantlets, exhibiting betalain pigmentation on hypocotyls after being transferred onto hormone-free MS medium. The conversion rate of somatic embryos of different lengths (1, 2, 3 mm) into complete plantlets was similar (78, 81, and 85 % respectively). Secondary embryogenesis, which would be useful in providing somatic embryos for gene transfer purposes, was not observed in this study.

RHIZOCTONIA CROWN AND ROOT ROT EVALUATION FOR COMMERCIAL SUGARBEET HYBRIDS AT EAST LANSING, MI, 1995

J. M. Halloin and L. Hubble

Fourteen hybrid varieties plus a resistant check (RC = WC90318 = FC701/5) and a susceptible check (SC = USH23) were evaluated for their resistance to *Rhizoctonia* crown and root rot in the disease nursery maintained at East Lansing, MI. For several prior years we have experienced difficulty establishing disease sufficiently severe to discriminate susceptible from moderately resistant varieties. Several years of experimentation demonstrated that low disease severity apparently resulted from biological control of the disease in the established site. Therefore, the disease nursery was expanded to include another portion of the same field, allowing a longer rotation between plantings of sugarbeets. We anticipated that disease severity would be high on the new portion of the field used in the 1995 test. Three replications were planted in a randomized complete block design. Individual plots were single rows 25' long and 28" apart; plants were thinned to approximately 8 inch spacing four weeks after planting. Inoculum consisted of ground millet infected with *R. solani*, which was applied to the crowns of the sugarbeets just prior to layby. Roots were dug by hand in mid September and scored for disease on a scale of 0 = no disease

lesions to 4 = dead, or greater than 75 % of the root rotted (= RZ Score). There was very heavy infection in the nursery this year, with all roots containing lesions, and no statistically significant differences in disease severity among the commercial varieties in the test.

Variety	RZ Score
Beta 5344	4.00 A*
ACH 308	3.99 A
Beta 5603	3.96 A
SX 1105	3.96 A
ACH 197	3.94 A
HM E9	3.93 A
Beta 5823	3.90 A
Beta 5713	3.89 A
ACH 185	3.87 A
ACH 319	3.87 A
HM E17	3.85 A
US H23 (SC)	3.85 A
HM E10	3.84 A
US H20	3.84 A
Beta 5931	3.80 A
WC 90318 (RC)	3.44 B

* = Means followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

Cercospora Leaf Spot Evaluation of Commercial Varieties at East Lansing, MI, 1995.

J. M. Halloin and R. C. Zielke

A disease nursery is maintained at East Lansing, MI for selection and evaluation of resistance to *Cercospora* leaf spot. The results of evaluations of a group of 47 commercial hybrids and two checks (Edda = susceptible check, EL50 = resistant check) are given in this report. The entries each were planted in a randomized complete block experiment with three replications. Individual plots were single rows 25' long and 28" apart; plants were thinned to approximately 8 inch spacing four weeks after planting. Every third row in the experimental block was planted to the highly susceptible variety Edda (supplied by J. Miller, Betaseed, Inc.), in an attempt to maintain inoculum potential at a high level. When full leaf canopy was developed the plants were inoculated by hand dusting with finely ground *Cercospora*-infected leaves collected at the end of the 1994 season. Each plot in the disease nursery was scored for leaf spot severity on August 10 and August 24. Scores were on a basis of 0 = no disease to 9 = plants dead. *Cercospora* leaf spot scores of sugarbeet varieties in the commercial variety test at East Lansing, MI, 1995.

#	Variety	Leaf spot score			
		8/10/95		8/24/95	
49	Edda (Susc. Ck.)	3.67	A*	6.72	A
34	B. BG6916	3.33	AB	5.67	B
25	HMI E17	3.00	ABC	5.67	B
37	B. BG5902	3.00	ABC	5.67	B
6	HMI 2729	3.00	ABC	5.33	BC
26	VDH SIRIO	3.00	ABC	5.33	BC
29	B. 5504	3.00	ABC	5.33	BC
9	SX1209	2.67	BCD	5.67	B
10	US H20	2.67	BCD	5.67	B
27	B. BG5320	2.67	BCD	5.67	B
47	B. 5315	2.67	BCD	5.67	B
3	ACH 308 (89-220)	2.67	BCD	5.33	BC
33	HMI 2724	2.67	BCD	5.33	BC
41	ACH 94-489	2.67	BCD	5.33	BC
43	ACH 94-503	2.67	BCD	5.33	BC
4	B. 5585 (Blend)	2.67	BCD	4.67	BCD
5	B. 5823	2.67	BCD	4.67	BCD
7	B. BG6933	2.67	BCD	5.00	BCD
13	B. 5335	2.67	BCD	5.00	BCD
15	AC 9100230	2.67	BCD	5.00	BCD
19	B. BG6920	2.67	BCD	5.00	BCD
22	HMI E10	2.67	BCD	5.00	BCD
23	AC 9200154	2.67	BCD	5.00	BCD
40	ACH 94-433	2.67	BCD	5.00	BCD
35	B 5603	2.33	BCD	5.67	B
21	HMI 2728	2.33	BCD	5.33	BC
31	B. 5713 (BG6914)	2.33	BCD	5.33	BC
36	B. 5344	2.33	BCD	5.33	BC
46	HMI E9	2.33	BCD	5.33	BC
11	B. BG6945	2.33	BCD	5.00	BCD
28	B. 5931 (BG6931)	2.33	BCD	5.00	BCD
30	HMI 2727	2.33	BCD	5.00	BCD
20	ACH 197	2.33	BCD	4.67	BCD
45	ACH 520 (BLEND)	2.33	BCD	4.67	BCD
1	HMI 2726	2.33	BCD	4.33	CD
8	ACH 185	2.33	BCD	4.33	CD
14	ACH 319 (89-417)	2.33	BCD	4.33	CD
18	VDH MERCURIO	2.33	BCD	4.33	CD
39	ACH 94-149	2.33	BCD	4.33	CD
44	ACH 510 (BLEND)	2.00	CD	5.67	B
24	B. BG5311	2.00	CD	5.00	BCD
38	ACH 92-042	2.00	CD	5.00	BCD
42	ACH 94-500	2.00	CD	5.00	BCD
2	SX 1212	2.00	CD	4.67	BCD
32	HMI 2725	2.00	CD	4.67	BCD
12	HMI E4	2.00	CD	4.00	D
17	HMI E7	2.00	CD	4.00	D
48	EL50 (Res.Ck.)	1.67	D	4.67	BCD
16	B5639	1.67	D	4.00	D

* = Means followed by the same letter do not differ significantly at the 5% level using Duncan's Multiple range test.

EVALUATION OF SMOOTH ROOT
AND BREEDING LINES OF SUGARBEET - 1995

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CROP HISTORY

The 1995 sugarbeet field trials at the Bean and Beet Research Farm near Saginaw were planted in Range 6 tiers 5-8. This land had been fallow in 1994. The soil was prepared by fall plowing, followed by frost tillage in the early spring. Beets in the three experiments (951, 952, and 953) were planted on May 18, 1995. Pre-emergence herbicide (3 qt. Pyramin, 2 qt. Nortron SC, and 2 qt. Antor per acre) was applied by Paul Horny, Farm Manager, immediately following seeding. All three experiments had good seed germination and good plant stands after thinning, and excellent chemical weed control. Precipitation for May, June and July was 1.44, 1.96 and 1.29 inches respectively, about half the past average for the farm for that period. The plots were thinned to 8-10" between plants within the row and weeded the fourth week of June. Fertilizer at the standard recommended rate of 90 lbs. available N per acre was applied to the soil in tests 951 and 952 on June 8, 1995 by shank injection between rows. On June 29 experiment 953 was given differential nitrogen fertilizer treatments by side dressing the halves of each rep with 90 or 180# N/acre ammonium nitrate in accordance with the split plot field design. The field was cultivated once prior to layby. Experiments 951 and 952 were machine harvested October 19-20 and 26, respectively.

**EXPERIMENT 951 - AGRONOMIC EVALUATION OF PROGENIES DERIVED FROM
1994 INDIVIDUAL SMOOTH ROOT BEET SELECTIONS
WITH HIGH SUCROSE PERCENTAGE.**

This experiment was designed to evaluate sucrose percentage and the agronomic performance of a group of high sucrose smooth root (SR) progenies produced by J. Clair Theurer just prior to his retirement in April 1995. Individual beets with good SR shape and high sucrose percentage on a fresh weight basis ranging from 100-125% of that for ACH 185 had been selected from the 1994 SR breeding nursery. Seed was produced in groups with 4-28 roots in each group, depending upon the pedigree of the breeding material. The 18 SR progenies plus the commercial hybrid ACH 197 and smoothroot SR87 checks were planted in two row plots with rows 28" apart and 30 feet in length in a 6 replicate field trial. Just prior to harvest the length of each plot row was measured and adjustments made to correct for areas in the row where gaps were present and to determine the plot area. All roots were machine harvested for root weight and a fifteen beet sample from each plot was used for determining sucrose and clear juice purity (CJP) percentages. Sugar percentage and CJP percentages were determined by Michigan Sugar

Company personnel in their research lab at Carrollton, MI using standard thin juice methods. A root smoothness score was estimated for each plot by observing the beets in the weighing basket. Entries were scored on a 0-4 scale as defined below:

- 0 = Very smooth taproot, no grooves, broad fibrous root zone
- 1 = Smooth, slightly grooved taproot, narrow fibrous root zone
- 2 = Partially smooth, grooved, heavy fibrous non-branching taproot
- 3 = Rough shaped taproot, deep grooves, heavy fibrous roots with some sprangling
- 4 = Very rough, very deep grooves, multiple branched taproot.

Note that this scale has been shifted from a corresponding 1-5 scale in previous use. Data was analyzed using the Michigan State University MSTAT statistical program.

RESULTS

Due to a late planting and some dry weather, sugar per acre totals were relatively low this year in these experiments. Sugar production of the SR lines in this experiment ranged from 63% to 96% of ACH197. SR line 95HS4 had the highest RWSA of the SR lines and six other SR lines had RWSA not significantly different from ACH197 (Table 1). The two highest SR lines for RWSA (95HS4 and 95HS6) were both progenies from a very high RWSA line (94HS11) from the 1994 evaluation year. RWST of the SR lines ranged from 89 to 106% of ACH197; 95HS1 was significantly better than the commercial check. Root yield of the SR lines ranged from 67% to 97% of ACH 197, with four of the top five SR lines for tons per acre being derived from a very high tonnage line (94HS11) in the 1994 test year. The sucrose percentages for the SR lines ranged from 93 to 105% of ACH197, with the top SR line for sugar percentage (95HS1) being significantly better than the commercial check. When clear juice purity is considered, two lines (95HS7 and 95HS15) had a disproportionately high CJP% for their sucrose %, suggesting that non-sucrose impurity factors were relatively low. All SR lines had significantly better smooth root scores than the commercial check variety. 95HS15 and 95HS10 were significantly smoother than some of the other SR lines tested. The smooth root check SR87 was among the smoothest entries, but was not significantly smoother than two-thirds of the SR experimental entries. Overall, SR87 performed as expected, with the highest tonnage and lowest sucrose % in the test, and nearly as much sugar per acre as ACH197.

The high sugar lines with good RWSA identified in the 1994 and 1995 tests need further selection for smoothrootedness, probably in much larger selection blocks than have been employed in the past, before ready for release.

Table 1. Sugar yield, root yield, sucrose %, clear juice purity %, and smoothness score, for high sugar smooth root lines. Saginaw, MI. 1995.

Sugar Yield		Root Wgt.		T/AC		Suc %		CJP %		SR Score	
Variety/Line	RWSA #	RWST #									
ACH 197	5089* A	244.1	BCD	20.83	B	17.02	BCD	93.77	ABC	2.625	A
SR 87	4995 AB	206.0	H	24.23	A	14.92	G	92.57	DE	1.333	EF
95HS1	4420 ABCDE	258.1	A	17.11	DEF	17.84	A	94.03	ABC	1.708	BCD
95HS2	4668 ABC	248.0	ABC	18.82	BCDE	17.17	ABC	94.06	ABC	1.583	BCDE
95HS3	4353 BCDEF	245.1	BCD	17.79	CDEF	17.11	ABC	93.71	ABC	1.583	BCDE
95HS4	4891 AB	241.5	BCDE	20.26	BC	16.98	BCDE	93.40	BCD	1.750	BCD
95HS5	4439 ABCDE	228.7	F	19.38	BCD	16.22	DEF	93.18	CD	1.583	BCDE
95HS6	4814 AB	253.4	AB	18.99	BCD	17.70	AB	93.58	ABC	1.583	BCDE
95HS7	4373 BCDEF	240.4	CDEF	18.17	CDEF	16.67	CDE	94.14	AB	1.458	DEF
95HS8	4072 CDEF	243.8	BCD	16.70	DEF	16.81	CDE	94.36	A	1.500	CDEF
95HS9	3866 DEFG	238.9	CDEF	16.13	EFG	16.69	CDE	93.71	ABC	1.833	B
95HS10	4566 ABCD	238.7	CDEF	19.13	BCD	16.76	CDE	93.53	ABC	1.333	EF
95HS11	4353 BCDEF	249.6	ABC	17.40	DEF	17.24	ABC	94.15	AB	1.625	BCDE
95HS12	3737 EFG	217.5	G	17.13	DEF	15.77	F	92.29	E	1.750	BCD
95HS13	3230 G	231.2	EF	13.99	G	16.21	EF	93.69	ABC	1.708	BCD
95HS14	4105 CDEF	235.0	DEF	17.43	DEF	16.65	CDE	93.15	CD	1.792	BC
95HS15	3676 FG	233.1	DEF	15.74	FG	16.25	DEF	94.00	ABC	1.250	F
95HS16	4319 BCDEF	243.1	BCDE	17.77	CDEF	17.17	ABC	93.15	CD	1.458	DEF
95HS17	4107 CDEF	240.4	CDEF	17.13	DEF	16.95	BCDE	93.27	BCD	1.458	DEF
95HS18	4650 ABC	249.5	ABC	18.64	BCDE	17.34	ABC	93.85	ABC	1.500	CDEF
Mean	4336	239.3		18.14		16.77		93.58		1.62	

*Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

EXPERIMENT 952 - EVALUATION OF SMOOTHROOT MONOGERM DEVELOPMENTAL LINES

This experiment consisted of 18 entries planted in 6 replications of plots 28 inches between rows and 30 feet in length. Emergence was excellent in all cases except with the smoothroot check, SR87, where it was acceptable but noticeably sparser prior to thinning. Entries 95H1 through 95H7 were from seven crosses of individual plants of SR80 or SR87 x recently released monogerm leafspot resistant line EL50. 93293 and 94494 are multigerm sister lines derived from a combination of SR87, L19, EL48 and SP6926 in descending order of parentage percentage. All remaining experimental entries are related to these sister lines except for WC92408 which is a composite of East Lansing and Beltsville germplasm, including some smoothroot, from the mid- and early 1980's. The experiment was harvested and laboratory analyses were made using the same methods as stated in Experiment 951.

RESULTS

Six of seven EL50 derivatives (the 95H series of entries), the SR87 check, one of the SR87 X L19 etc derivatives, and the Belts.-EL mid 80's composite achieved RWSA not significantly different from the commercial check ACH197, though none exceeded the commercial by much (Table 2). All experiments were significantly lower in RWST than commercial ACH197, falling out into two groups, those with moderate RWST levels such as all the EL50 derivatives, the mid 80's composite and 576CMS X JS596118, and those with low RWST, including SR87 and remaining SR87 X L19 etc derivatives. The RWST superiority of ACH197 rested primarily on it's significantly higher sucrose percentage. For this test, moderate levels of sucrose % were achieved by all the EL50 derivatives, the mid 80's composite, and the 576CMS X JS596118 hybrid. The latter hybrid also topped the CJP rating, although not significantly highest. Best smoothroot scores were achieved by the smoothroot check SR87 and the SR87 X L19 etc sister lines 93293 and 94494, whereas worst smoothroot scores were posted by ACH197 and the mid 1980's composite WC92408. The other lines had less smoothroot heritage or selection history.

95H6 warrants future attention because of its somewhat better performance in this test. While monogerm is segregating in these EL50 derived populations, their narrow base (EL50 is a two plant cross population) may preclude segregation of O-types.

Table 2. Sugar yield, root yield, sucrose %, and clear juice purity %, smoothness score, for smooth root and/or monogerm developmental lines. Saginaw, MI. 1995.

Variety/Line	Sugar Yield				Root Wt.			
	RWSA #	RWST #	T/AC	Suc %	CJP %	SR Score		
ACH 197	6475* AB	267.6 A	24.17 ABCD	18.49 A	93.94 AB	2.458 A		
SR 87	5426 BCD	221.3 FG	24.52 ABC	15.83 GH	92.89 CD	1.167 I		
95H1	5335 BCD	232.1 E	22.99 ABCD	16.47 DEF	93.11 BCD	1.417 H		
95H2	5417 BCD	243.2 BCD	22.26 BCDE	17.08 BC	93.44 ABC	1.833 BCDE		
95H3	5356 BCD	243.6 BCD	21.98 BCDE	17.08 BC	93.50 ABC	1.500 GH		
95H4	4931 CDE	235.4 DE	20.92 DEF	16.69 CDE	93.08 BCD	1.750 CDEF		
95H5mm	5301 BCD	248.2 B	21.37 CDEF	17.42 B	93.40 ABC	1.583 FGH		
95H6	6426 AB	245.4 BC	26.20 A	17.34 B	93.12 BCD	1.708 DEFG		
95H7	5842 ABC	231.7 E	25.23 AB	16.59 CDE	92.68 CDE	1.625 EFGH		
576CMS X JS596118	5095 CDE	237.5 CDE	22.56 BCDE	16.46 DEF	94.14 A	1.875 BCD		
94F02	4344 DEF	221.2 FG	19.61 EFG	15.82 GH	92.92 CD	1.958 BC		
95J01/95J02 mm	5155 CDE	219.9 FG	23.43 ABCD	15.94 FGH	92.32 DE	2.000 B		
H23/CMS X JS596118	5403 BCD	221.7 FG	24.20 ABCD	15.84 GH	92.94 CD	1.625 EFGH		
95J07	3668 F	217.6 G	16.73 G	15.87 FGH	92.05 E	1.792 BCDEF		
JS596118	4848 CDE	229.3 EF	21.03 DEF	16.14 EFG	93.54 ABC	1.500 GH		
93293	5068 CDE	216.9 G	23.35 ABCD	15.40 H	93.30 ABC	1.125 I		
94494	4078 EF	216.7 G	18.76 FG	15.46 H	93.10 BCD	1.208 I		
WC92408	5690 BC	238.7 CDE	23.86 ABCD	16.86 BCD	93.23 BC	2.500 A		
Mean	5215	232.7	22.40	16.49	93.15	1.70		

*Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05

EVALUATION OF SELECTION LINES FOR NITROGEN USE RESPONSE - 1995

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Nitrogen fertilization is a critical component of growing a good sugarbeet crop. Sufficient N is required for rapid early growth and quick development of a full canopy of leaves for maximum photosynthesis, plant growth, and sucrose accumulation. Excess N at harvest results in higher impurities in the root and less efficiency in processing to sugar. Additionally, there is growing concern about the quantity of nitrogenous chemicals in natural bodies of water. In 1990 a research program was initiated to evaluate diverse genotypes for their potential difference in tolerance to high N or their efficiency for high sugar production with low nitrogen availability. Minor differences in N response were noted for some genotypes in past years. In 1995 we continued research on nitrogen and genotypes by evaluating the response of several amino-N level selection populations to differential nitrogen fertilization treatments.

Two high sucrose percentage source populations, (WC91270M and 93S1-00) were included in the experiment, as were seven and two selection lines from them respectively. The commercial check ACH185 was included as a general reference entry. Both selection lines from 93S1-00 were produced from a single cycle of selection for high sucrose % and low amino-N of beets grown under standard (i.e., 90# per acre) nitrogen rates. Each selection line was a pair cross made by crossing two beets which had been half-rooted for sucrose and amino-N determinations. Three of the seven selection lines from WC91270M were similarly produced, three more involved pair crosses of half-roots selected for high sucrose % and high amino-N, and the seventh line (95N16) was an intercrossing of ten half-rooted beets high in sucrose % and low in amino-N (Table 3-1). The total of twelve entries were planted in a randomized block factorial experiment of three replications split for two nitrogen levels at the Bean and Beet Research Farm on May 18, 1995. Individual plots were single rows because of limited seed quantities, but were of standard length and width spacing, i.e., 28" apart and 30' in length. A single spacer row of ACH197 was planted between test rows to standardize interrow competition.

Test 953 was planted in Range 6 tiers 7-8. This land had been fallow in 1994. The soil was prepared by fall plowing, followed by frost tillage in the early spring. Beets were planted on May 18, 1995. Pre-emergence herbicide (3 qt. Pyramin, 2 qt. Nortron SC, and 2 qt. Antor per acre) was applied by Paul Horny, Farm Manager, immediately following seeding. Precipitation for May, June and July was 1.44, 1.96 and 1.29 inches respectively, about half the past

average for the farm for that period. The plots were thinned to 8-10" between plants within the row and weeded the fourth week of June. On June 29 experiment 953 was given differential nitrogen fertilizer treatments by side dressing the halves of each rep with 90 or 180# N/acre ammonium nitrate in accordance with the split plot field design. The field was cultivated once prior to layby. Experiment 953 was machine harvested October 17, 1995. The length of each plot was measured just prior to harvest to adjust plot size for any gaps within the rows. All roots in each plot were weighed to determine root yield and RWSA. A fifteen beet random sample of roots was taken from each plot to determine sucrose percentage, CJP percentage and meq amino N per 100 g. sugar. These determinations were made by Michigan Sugar Company personnel at their research lab in Carrollton, MI. Data was summarized and analyzed using the MSTAT statistical program developed at Michigan State University.

RESULTS

Plant stand for all entries was good. Means of nitrogen application levels summed over lines for sugar yield, root yield, sucrose percent, CJP, and meq. amino N/100 grams of sugar are given in Table 3-2. In this test, neither RWSA nor tons/acre increased with nitrogen rate, as is the usual pattern (Table 3-2). The two nitrogen application levels showed an insignificant difference between RWSA means as well as tons per acre. However, the means of the three processing quality parameters (suc%, CJP and amino-N) as well as their product RWST were significantly different at the two nitrogen levels, in the order consistent with countless independent nitrogen application level tests performed by other researchers: as the quantity of N fertilizer is increased, amino-N in the root increases, while RWST, sucrose percent and CJP decreases. Means of lines summed over nitrogen levels shows highly significant differences for all characteristics measured (Table 3-3). The ACH 185 commercial variety reference check had the significantly highest RWSA, whereas 93S1-00 and one of its two selection lines had the lowest RWSA, about 60% of the commercial check RWSA value. A high amino-N selection line (93N12) from L19/2 had the highest sucrose percentage and RWST in the experiment, but neither mean was significantly different from the L19/2 source population. Lowest sugar yields per acre came from 93S1-00 and one of its selection lines, as well as a high amino-N selection lines from L19/2. An L19/2 low amino selection (95N13) had the highest purity despite having the highest amino-N reading, although neither score was significantly different than the L19/2 source population. Selection line 95N10 had significantly less tonnage per acre and RWSA than it's source population L19/2, the only case where a selection line performed significantly worse than the source population. There was only a single case of a selection line significantly outperforming its respective source population, i.e. 95N14 had a higher tonnage of beets per acre as well as greater RWSA than 93S1-00.

The performance data were further broken down to individual treatment combination comparisons, at either nitrogen application level (Table 3-4). A t-test was run to permit closer comparison of

the mean of any selection line at either nitrogen level only with the mean of the respective source population at that level (Table 3-4). This identified only one selection line where the pair of means for one parameter was significantly different for both nitrogen levels, providing an indication of a consistent difference. This was the selection line also identified from the table of means summed over nitrogen application levels, i.e., 95N10 with lower RWSA.

DISCUSSION

There were two alternatives or selection schemes planned in our original premise to search for genotypes with greater nitrogen use efficiency: 1) genotypes that could metabolize an excess of nitrogen fertilizer without decreasing the sucrose content or increasing the amino N and other impurities in the sugarbeet root at harvest; and 2) genotypes that could produce a satisfactory root and sugar yield with a limited quantity of nitrogen. The 1995 test identified one selection product (95N14) that had lower CJP and amino-N than its source population (93S1-00) and nearly half again as much root tonnage and 30% more RWSA. Another selection line (95N12) had the highest sucrose % and the most stable amino-N and CJP scores in the test over the two nitrogen application rates, even when compared with its source population. Overall, direction of selection (i.e., low vs. high amino-N) did not display an effect, although this was not tested statistically.

One important aspect of this study was the use of pair crosses of the half-rooted beets. This resulted in limited seed quantities which reduced the test to a single row, three rep experiment, the bare minimum scale for meaningfulness. In addition, some inbreeding depression may have occurred that would be a confounding, perhaps in some cases offsetting, factor in the resultant performance results. All six pair-cross selection lines from L19/2 had at least considerably lower tons per acre and RWSA than the source population (only one significantly lower), whereas the ten-parent plant population was similar to the source population for these parameters. Pair cross results can often also be confounded by sampling effects that coincidentally produce assortative pair wise matings for parameters which are indirectly related to the selection criteria. These may either yield more or less favorable directional changes in performance parameters. This experiment was not set up on a large enough scale to avoid all these potential confoundings. Nevertheless, a combination of selection and favorable sampling effect could produce some lines with more favorable performance capabilities. Despite lower root tonnage compared with source L19/2, selection line 95N12 had considerably lower amino-N and higher sucrose % and CJP, and could be one such line.

Table 3-1. Description of genotypes used in selection for nitrogen use efficiency study.

Genotype	Description
1. ACH 185	COMMERCIAL
2. WC91270M	L19/2
3. 93S1-00	L19-C51 F ₄
4. 95N14	L19-C51 F ₄ , HI SUG LOW AMINO-N SELECTION
5. 95N7	L19/2, HI SUG LOW AMINO-N "
6. 95N8	L19/2, HI SUG LOW AMINO-N "
7. 95N9	L19/2, HI SUG LOW AMINO-N "
8. 95N10	L19/2, HI SUG HI AMINO-N "
9. 95N12	L19/2, HI SUG HI AMINO-N "
10. 95N13	L19/2, HI SUG HI AMINO-N "
11. 95N16	L19/2, HI SUG LOW AMINO-N "
12. 95N15	L19-C51 F ₄ , HI SUG LOW AMINO-N "

Table 3-2. Means for N level summed across varieties for sugar yield, root yield, sucrose percentage, clear juice purity percentage, and meq amino N/100 g sugar. B&B Farm. 1995.

N level	Sugar Yield		Root Wt.		Amino N	
# Acre	RWSA #	RWST #	T/A	Suc%	CJP%	meq/100 g sug.
90	4322*A	244.2 A	17.66 A	17.35 A	92.92 A	15.02 A
180	4042 A	232.3 B	17.40 A	16.87 B	92.05 B	21.50 B
mean	4182	238.26	17.53	17.11	92.49	18.26

*Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

Table 3-3. Means for varieties summed across N Levels, sugar yield, root yield, sucrose percentage, clear juice purity percentage, and meq amino N/100 g sugar. B&B Farm. 1995.

Variety	Sugar Yield		Root Wt.		Amino N		
	RWSA #	RWST #	T/A	Suc %	CJP %	meq/100 g suc.	
ACH185	5546*A	236.6 ABCD	23.44 A	17.07 ABC	92.28 ABC	17.97 AB	
WC91270M	4657 B	239.7 ABCD	19.48 BC	17.31 ABC	92.14 ABC	20.33 AB	
93S1-00	3355 C	239.1 ABCD	13.90 D	17.38 ABC	91.96 BC	18.47 AB	
95N14	4335 B	226.1 D	19.02 BC	16.18 C	92.80 ABC	14.82 B	
95N7	4171 B	246.5 ABC	16.81 C	17.55 ABC	92.77 ABC	18.22 AB	
95N8	4265 B	248.7 AB	17.09 C	17.55 ABC	93.23 A	17.27 B	
95N9	4418 B	230.7 BCD	19.03 BC	16.61 ABC	92.48 ABC	19.99 AB	
95N10	3192 C	228.0 CD	14.08 D	16.45 BC	92.38 ABC	17.43 B	
95N12	4335 B	253.7 A	17.13 C	17.90 A	93.09 AB	15.90 B	
95N13	4190 B	242.0 ABCD	17.31 BC	17.67 AB	91.68 C	23.06 A	
95N16	4622 B	229.6 BCD	20.04 B	16.65 ABC	92.11 ABC	19.57 AB	
95N15	3100 C	238.4 ABCD	12.98 D	16.96 ABC	92.93 AB	16.10 B	
MEAN	4182	238.2	17.53	17.11	92.49	18.26	

*Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

Table 3-4. Sugar yield, root yield, sucrose percentage, clear juice, purity percentage, and meq amino N/100 g sugar for sugarbeet genotypes grown under two N environments. B&B Farm. 1995.

Variety	RWSA #		T-TEST ^b	RWST #		T-TEST	LEVEL N#/A
ACH 185	5459 ^a	AB		237.5	ABCDEFGF		90
	5633	A		235.7	ABCDEFGF		180
WC9127OM	4927	ABC		259.9	A		90
	4388	ABCD		219.6	FG		180
93S1-00	3774	CDEF		254.8	ABC		90
	2936	F		223.5	DEFG		180
95N14	4586	ABC	NS	236.1	ABCDEFGF	NS	90
	4083	CDEF	NS	216.1	G	NS	180
95N7	4173	BCDEF	NS	244.8	ABCDEF	NS	90
	4169	BCDEF	NS	248.1	ABCDE	*	180
95N8	4383	ABCD	NS	246.7	ABCDEF	NS	90
	4147	BCDEF	NS	250.6	ABCD	NS	180
95N9	4571	ABC	NS	240.3	ABCDEFGF	NS	90
	4264	BCDE	NS	221.2	EFG	NS	180
95N10	3174	DEF	**	240.0	ABCDEFGF	*	90
	3211	DEF	*	216.0	G	NS	180
95N12	4772	ABC	NS	257.9	AB	NS	90
	3898	CDEF	NS	249.5	ABCD	*	180
95N13	4305	BCDE	NS	243.7	ABCDEF	*	90
	4076	CDEF	NS	240.3	ABCDEFGF	NS	180
95N16	4702	ABC	NS	231.6	BCDEFG	*	90
	4542	ABC	NS	227.6	CDEFG	NS	180
95N15	3040	EF	NS	237.1	ABCDEFGF	NS	90
	3160	DEF	NS	239.7	ABCDEFGF	NS	180
ACH 185	22.99	AB		17.03	ABCD		90
	23.90	A		17.10	ABCD		180
WC9127OM	18.95	BCD		18.35	A		90
	20.02	ABC		16.28	BCD		180
93S1-00	14.84	DEF		18.44	A		90
	12.95	F		16.32	BCD		180
95N14	19.31	BCD	NS	16.63	ABCD	*	90
	18.72	BCD	NS	15.74	D	NS	180

Variety	TONS/ACRE	T-TEST	SUCROSE%	T-TEST	LEVEL	N#/A
95N7	16.86 CDEF	NS	17.36 ABCD	NS	90	
	16.77 CDEF	NS	17.74 ABC	*	180	
95N8	17.71 CDE	NS	17.35 ABCD	NS	90	
	16.48 CDEF	NS	17.74 ABC	NS	180	
95N9	18.92 BCD	NS	16.90 ABCD	NS	90	
	19.14 BCD	NS	16.33 BCD	NS	180	
95N10	13.20 EF	*	17.09 ABCD	*	90	
	14.96 DEF	NS	15.82 CD	NS	180	
95N12	18.54 BCD	NS	18.14 AB	NS	90	
	15.71 CDEF	*	17.65 ABCD	NS	180	
95N13	17.63 CDE	NS	17.67 ABCD	**	90	
	16.98 CDEF	NS	17.66 ABCD	NS	180	
95N16	20.11 ABC	NS	16.52 ABCD	*	90	
	19.96 ABC	NS	16.79 ABCD	NS	180	
95N15	12.81 F	NS	16.71 ABCD	NS	90	
	13.16 EF	NS	17.22 ABCD	NS	180	
ACH 185	92.54 ABC		13.41 EF		90	
	92.02 ABC		22.54 ABCD		180	
WC9127OM	92.97 ABC		14.81 DEF		90	
	91.31 C		25.85 AB		180	
93S1-00	91.92 ABC		17.79 BCDEF		90	
	92.01 ABC		19.15 ABCDEF		180	
95N14	93.41 A	NS	11.69 F	NS	90	
	92.20 ABC	NS	17.95 BCDEF	NS	180	
95N7	93.00 ABC	NS	15.50 CDEF	NS	90	
	92.54 ABC	**	20.94 ABCDE	NS	180	
95N8	93.49 A	NS	14.23 EF	NS	90	
	92.96 ABC	*	20.31 ABCDE	*	180	
95N9	93.46 A	NS	14.51 DEF	NS	90	
	91.49 BC	NS	25.48 AB	NS	180	

Variety	CJP%	T-TEST	AMINO N% S	T-TEST	LEVEL N#/A
95N10	92.84 ABC	NS	14.50 DEF	NS	90
	91.91 ABC	NS	20.36 ABCDE	NS	180
95N12	93.18 AB	NS	15.15 CDEF	NS	90
	93.00 ABC	*	16.65 CDEF	*	180
95N13	91.97 ABC	NS	19.90 ABCDEF	NS	90
	91.38 C	NS	26.21 A	NS	180
95N16	92.84 ABC	NS	15.83 CDEF	NS	90
	91.38 C	NS	23.30 ABC	NS	180
95N15	93.44 A	*	12.98 EF	**	90
	92.42 ABC	NS	19.22 ABCDEF	NS	180

^a Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

^b Each mean compared only with the mean of its appropriate source population; NS, * and ** indicate nonsignificance, and significance at the 0.05 and 0.01 levels, respectively.

Sugarbeet somatic embryos from callus: physiological and genotypic influences.

J.W. Saunders and C.J. Tsai

ABSTRACT. Two sugarbeet genotypes, REL-1 and LTR-41, were used to test combinations of abscisic acid (ABA) with the growth regulators 6-benzyladenine (BA) and naphthalene acetic acid (NAA), with different sole nitrogen sources, and with different sucrose concentrations with the goal of increasing somatic embryo production potential. LTR-41 produced up to forty fold more embryos than REL-1. At some concentrations, NAA as well as urea and glutamine stimulated greater embryo production over the control, but only for REL-1, where there was greater room for improvement. Three and five percent sucrose were superior to one, seven and nine percent. Increasing BA concentration was associated with diminishing embryo numbers but greater shoot regeneration numbers. LTR-41 was significantly better, clearly so, to REL-1 in shoot regeneration. As a common factor in all experiments, ABA at some concentrations consistently improved embryo production, and was seen to stimulate shoot production when this was measured. Genotype LTR-41 is being released as REL-2 to avail sugarbeet researchers of its superior embryogenic and shoot regeneration abilities for application in biotechnology.

Somatic embryogenesis involves the formation of embryo-like structures from somatic, i.e., non-germ, cells. Although somatic

embryos have been produced from zygotic embryos, including in sugarbeet (Tenning et al., 1992), callus or suspension culture cells are the most commonly used source for induction of somatic embryos. Somatic embryos are currently under investigation in species such as alfalfa and celery for use in production of artificial seeds (Gray and Purohit, 1991). Elite highly productive individual genotypes from genetically heterogeneous cultivars would be vegetatively reproduced on a large scale as somatic embryos and delivered to the field following conditioning and coating, or with fluid drilling. Superior-combining male sterile clones of sugarbeet could be propagated efficiently for use in production of commercial hybrid seed. Somatic embryos have also found use in genetic transformation with walnut (McGranahan et al., 1990) and *Datura innoxia* (Ducrocq et al., 1994). Synthetic seed production as well as gene transfer would be more efficient if somatic embryogenesis also recurred via subsequent cycles whereby multiple new embryos arose from existing ones in self replicating production, called secondary somatic embryogenesis.

Somatic embryos in sugarbeet callus or suspension cultures have been reported anecdotally by a number of authors (Atanasov, 1976; Tetu et al, 198; Freytag et al, 1988; Doley and Saunders, 1989; Kubalikova, 1990; d'Halluin et al, 1992). Tetu et al. (1987) concluded that multiple hormonal sequences were necessary for the induction and development of somatic embryos from callus. In contrast, Doley and Saunders (1989) reported the simple production and partial germination of somatic embryos from leaf disc hormone-autonomous callus of a fodder beet cultivar without the use of growth regulators. Tsai and Saunders (in press) extended this work to sugarbeet biotech clone REL-1 by demonstrating that somatic embryos, albeit in low frequency (one per ml of plated suspension), could be recovered from callus after plating suspensions grown with Murashige-Skoog (MS) medium plus 1 mg/L 6-benzyladenine (BA) onto MS hormone free medium. This same work discovered that certain concentrations of abscisic acid (ABA) in the plating medium increased the somatic embryo yield of plated suspensions of REL-1 up to fifteen fold.

Driven by a desire to increase the yield of somatic embryos and to search for procedures to induce secondary embryogenesis, we turned our attention to a potentially better genotype, to the auxins naphthalene acetic acid (NAA) and 2,4-dichlorophenoxyacetic acid (2,4-D), to the cytokinin BA, to different sole nitrogen sources, and to various concentrations of the standard carbohydrate source sucrose. Recalling that a presently deceased plant from line EL45/2 had produced several somatic embryos on leaf disc callus grown on hormone-free MS medium in earlier work (Doley and Saunders, 1989), the clonal seed collection was searched and provided a small quantity of seed from which several hybrid plants between EL45/2-105 and REL-1 were grown. One of these, LTR-41, was found superior to REL-1 for somatic embryogenesis and was entered into these studies.

MATERIALS AND METHODS

Experiments were performed with the diploid sugarbeet (*Beta vulgaris* L.) clones LTR-41 and REL-1, the former released to the public in 1987. REL-1 has been maintained in shoot culture (Saunders, 1982) and is available upon request, either as in vitro shoots, whole plants, or S₁ seed. Clone 6926cms12 (from SP6926-01) was tested in one experiment.

The culture media contained MS mineral salts (Murashige and Skoog, 1962), 100 mg/l myo-inositol, 1.0 mg/L thiamine HCl, 0.5 mg/L nicotinic acid, 0.5 mg/L pyridoxine HCl, and 30 g/L sucrose. Media used for leaf disc callusing were gelled with 9 g/L Difco Bacto agar, whereas media used in plating out were gelled with 3.5 g/L phytigel. The pH was adjusted to 5.95 prior to autoclaving. ABA was filter-sterilized and added into previously autoclaved and partially cooled media, as were sole nitrogen (nitrate, ammonium, urea, glutamine, glutamate, proline, glycine betaine and choline, each at 60 μ M atomic N) sources when these were compared. Culture vessels were 125 ml Erlenmeyer flasks or 20 x 100 mm Falcon disposable plastic Petri plates. Medium volume per vessel was 35 ml. Flasks were closed with foam caps and aluminum foil. Petri plates were sealed with one layer of Parafilm.

Callus was initiated from leaf discs (8 mm diameter) from partially expanded leaves of greenhouse grown plants on MS medium with 1 mg/l BA (Saunders et al., 1992) in Petri plates at 30 C in the dark. Callus was first seen after one month, and after another month, 2 to 3 g of leaf-disc callus was transferred to liquid hormone free MS medium in flasks for growth at 21 \pm 2 C in the dark. The suspension cultures were shaken on rotary shakers at 150 rpm to aerate the cultures and to reduce cell cluster size.

After 5-7 days, suspension cultures were subcultured with hormone-free MS medium for another 5-7 days. Suspensions used as inoculum were pushed through a stainless steel sieve with 830 μ m openings. Sieved suspensions for experiments with different nitrogen sources or sucrose levels were washed with nitrogen-free or sucrose-free liquid medium, respectively. Sieved suspension cells were plated on MS media with no growth regulators or with combinations of NAA and ABA, 2,4-D and ABA, or BA and ABA. Each Petri plate received 1 ml of suspension preparation containing about 0.1 g FW, and was incubated in dim light (less than 5 μ molm⁻²s⁻¹ from fluorescent lamps) at 25 C. Minimum size for an embryoid to be counted was 0.5 mm.

Analysis of variance was based on a randomized complete block design. The average number of somatic embryos and shoots per plate for each medium was subjected to ANOVA, and the least significant difference (LSD) test (α =0.05) was performed to permit individual treatment comparisons.

RESULTS AND DISCUSSION

Suspensions of REL-1 plated onto media with combinations of NAA and ABA gave variable but low numbers of embryos, with ABA combinations promoting embryogenesis at NAA concentrations of 1.0 mg/L or less (Fig. 1). The base level of embryo production, found at the 0 NAA and 0 ABA combination, was nearly one per plate. Production peaked at more than six embryos per plate, for 1.0 mg/L NAA and 0.1 mg/L ABA. In contrast, genotype 6926cms12 produced only a few embryos, at only two combinations of NAA and ABA (Fig. 2). Much higher embryo production was encountered with genotype LTR-41, with a base level of nearly 40 embryos per plate (Fig. 3). At all but the highest NAA level, media containing ABA at 0.1 or 0.3 mg/L bested nonABA-containing media for embryo production. Embryo production was lowest at the highest level of NAA, possibly due to reduced growth rates at this high concentration, as reflected by total fresh weight of the callus and embryos (Fig. 4).

In some species, 2,4-D is very effective in inducing somatic embryos. In the concentration range 0.1 to 1.0 mg/L, 2,4-D did not have that effect with LTR-41. There was a slight inhibitory effect at the higher concentrations of 2,4-D, probably indicating a general growth inhibition (Fig. 5). The stimulatory effect of 0.1 mg/L ABA on embryo production, and the inhibitory effect of 1.0 mg/L ABA are seen at all concentrations of 2,4-D.

A low frequency of somatic embryogenesis, not higher than six per ml of plated suspension, was seen following plating of REL-1 onto media containing different concentrations of BA and ABA, either individually or in combination (Fig 6). Summed over ABA concentrations, somatic embryo production diminished with increasing BA concentration. Furthermore, within each BA level, the ABA-less medium always yielded fewer somatic embryos than at least one of the ABA containing media. In contrast, the yield of shoots rose with increasing BA concentration. Furthermore, at BA concentrations of 0.3 and 1.0 mg/L, shoot yield increased with increasing ABA level as well, reaching a value of 68 embryos per plate (from one ml of plated suspension).

Platings of suspension from clone LTR-41 showed a similar pattern of decreasing embryo and increasing shoot numbers with increasing BA concentration (Fig. 7), and yielded considerably more somatic embryos as well as shoots compared with REL-1. For example, averaged over ABA concentrations, LTR-41 produced nine times more embryos in the absence of BA. Furthermore, LTR-41 produced 3.5 and 2 times more shoots at 0.3 and 1.0 mg/L BA respectively, averaged over all ABA levels. A differential stimulatory effect of moderate ABA concentrations on embryo production is evident, and this was significant at 0 and 0.1 mg/L BA. Within BA levels, the presence of ABA stimulated shoot production, most notably with BA at 0.3 and 1.0 mg/L.

The influence of sucrose concentration in the plating medium on somatic embryo production was examined in conjunction with applied levels of ABA with clone LTR-41. Embryo production peaked at 3% sucrose, which is the standard sucrose concentration used in our lab for all sugarbeet tissue culture operations (Fig. 8). Inclusion of 0.2 mg/L ABA as the only growth regulator in the plating medium significantly altered embryo numbers only at 3 and 5 % sucrose, where they increased.

Sole nitrogen sources were tested in combination with three concentrations of ABA as the only growth regulator in the plating medium for both clones. With REL-1, only glutamine and urea, at ABA concentrations of 2.0 and 0.2 mg/L respectively, served to significantly increase embryo production over the MS nitrogen mix control, ie, the standard in other studies from this lab (Fig. 9). Embryo production for most nitrogen sources was greater at least one of the ABA concentrations than in its absence. Shoot production for each nitrogen source averaged over ABA levels generally mirrored embryo production. Neither embryos nor shoots were produced on glycine betaine, choline, or in the absence of nitrogen. With clone LTR-41, top embryo production was four times higher than with REL-1, and no nitrogen source gave a higher production than the MS mix control (Fig. 10). Only urea and glutamine in addition to the MS mix produced considerable numbers of somatic embryos. Additionally, with the more embryogenic clone LTR-41, shoot production did not mirror embryo production when nitrogen sources are compared as noted for clone REL-1, nor were glycine betaine, choline, or the nitrogen-free media unproductive of embryos or shoots.

This research has resulted in identification of a superior genotype (LTR-41) for somatic embryogenesis in sugarbeets, one that also produces more than five fold more shoots per unit callus than REL-1. These two properties may be related. LTR-41 has just been released to the public as REL-2. Like REL-1, REL-2 is a self-fertile annual clone, with minimal shoot vitreousness in tissue culture. REL-2 (old LTR-41) should find use in transgenic research, in further improvement of the somatic embryo production system, and in somatic cell selection where greater shoot regeneration is needed.

The strong promotive effect of ABA on somatic embryogenesis seen in the preceding work (Tsai and Saunders, in press) was confirmed in the present endeavors with two genotypes and in various nutritional contexts with nitrogen source and sucrose concentration. Exogenous ABA improved somatic embryo production from leaf pieces of orchardgrass (Bell et al, 1993). High internal levels of ABA have been implicated in permitting somatic embryogenesis from leaf explants of Napier grass (Rajasekaran et al, 1987), and the involvement of ABA in regulating the continued normal development of somatic embryos has been known for some time (Ammirato, 1974, 1983). It is interesting to speculate whether young leaves of LTR-41 might also have high ABA levels, as leaf discs from them produce

embryogenic callus in the absence of growth regulators in the medium. Furthermore, this research shows for the first time that ABA is promotive of shoot regeneration from sugarbeet callus, from both genotypes examined. This influence should prove useful in situations where callus appears reluctant to regenerate shoots, such as after prolonged cell selection efforts.

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FIGURES

- Fig. 1: The influence of NAA and ABA on somatic embryo with genotype REL-1. For all figures, means marked with same letter are not significantly different according to LSD with p 0.05.
- Fig. 2: The influence of NAA and ABA on somatic embryo production with genotype 6926cms12.
- Fig. 3: The influence of NAA and ABA on somatic embryo production with genotype LTR-41.
- Fig. 4: The influence of NAA and ABA on combined fresh weight of callus and somatic embryos with genotype LTR-41.
- Fig. 5: The influence of 2,4-D and ABA on somatic embryo production with genotype LTR-41.
- Fig. 6: The influence of BA and ABA on somatic embryo and shoot production with genotype REL-1.
- Fig. 7: The influence of BA and ABA on somatic embryo and shoot production with genotype LTR-41.
- Fig. 8: The influence of sucrose concentration and ABA on somatic embryo production with genotype LTR-41.
- Fig. 9: The influence of sole nitrogen source and ABA on somatic embryo and shoot production with genotype REL-1.
- Fig. 10: The influence of sole nitrogen source and ABA on somatic embryo and shoot production with genotype LTR-41.

Influence of NAA and ABA on somatic embryo production. Genotype REL-1 callus initiated on MS medium with BA 1 mg/l.

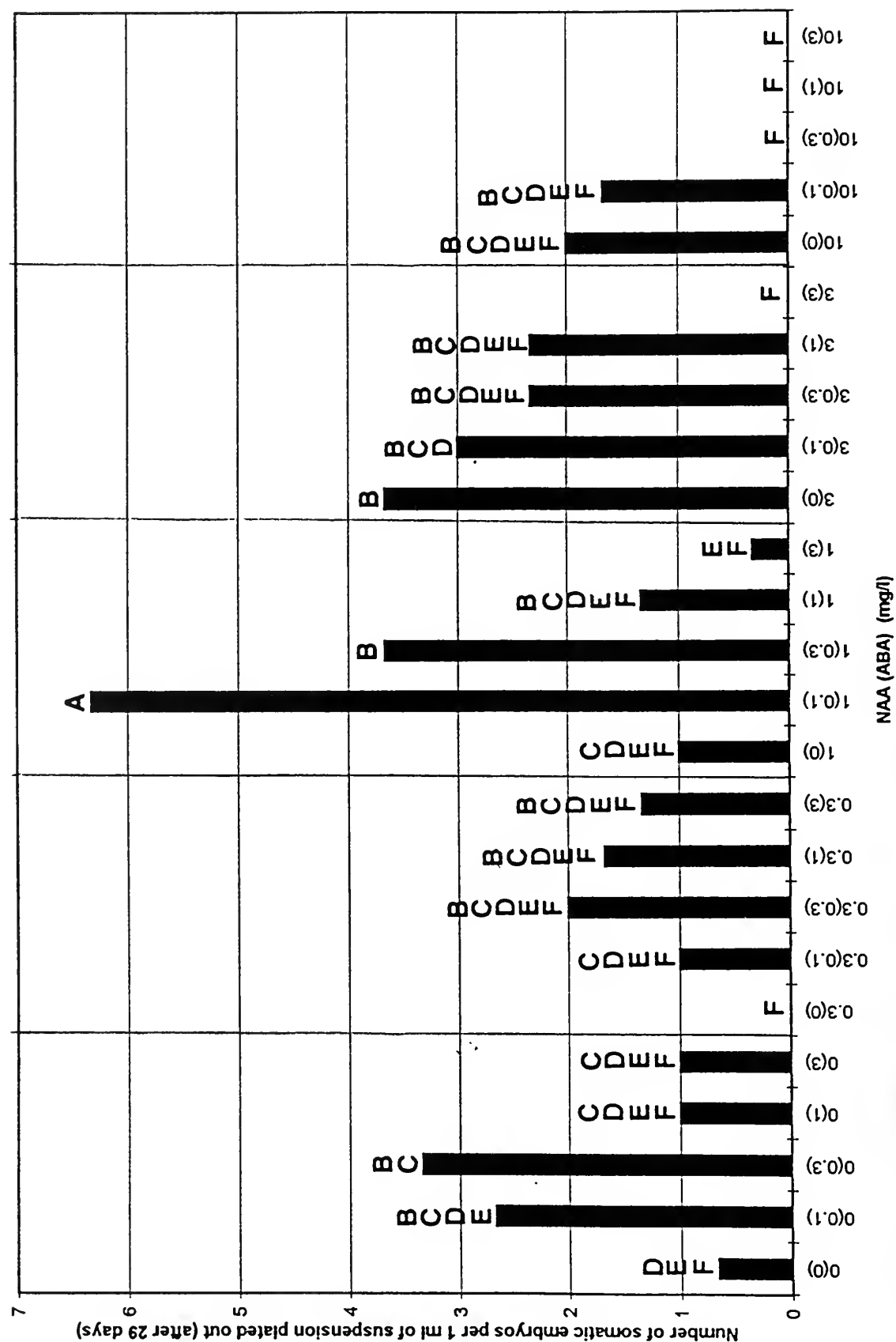


Fig. 2

Influence of NAA and ABA on somatic embryo production. Genotype 6926cms12 callus initiated on MS medium with BA 1 mg/l.

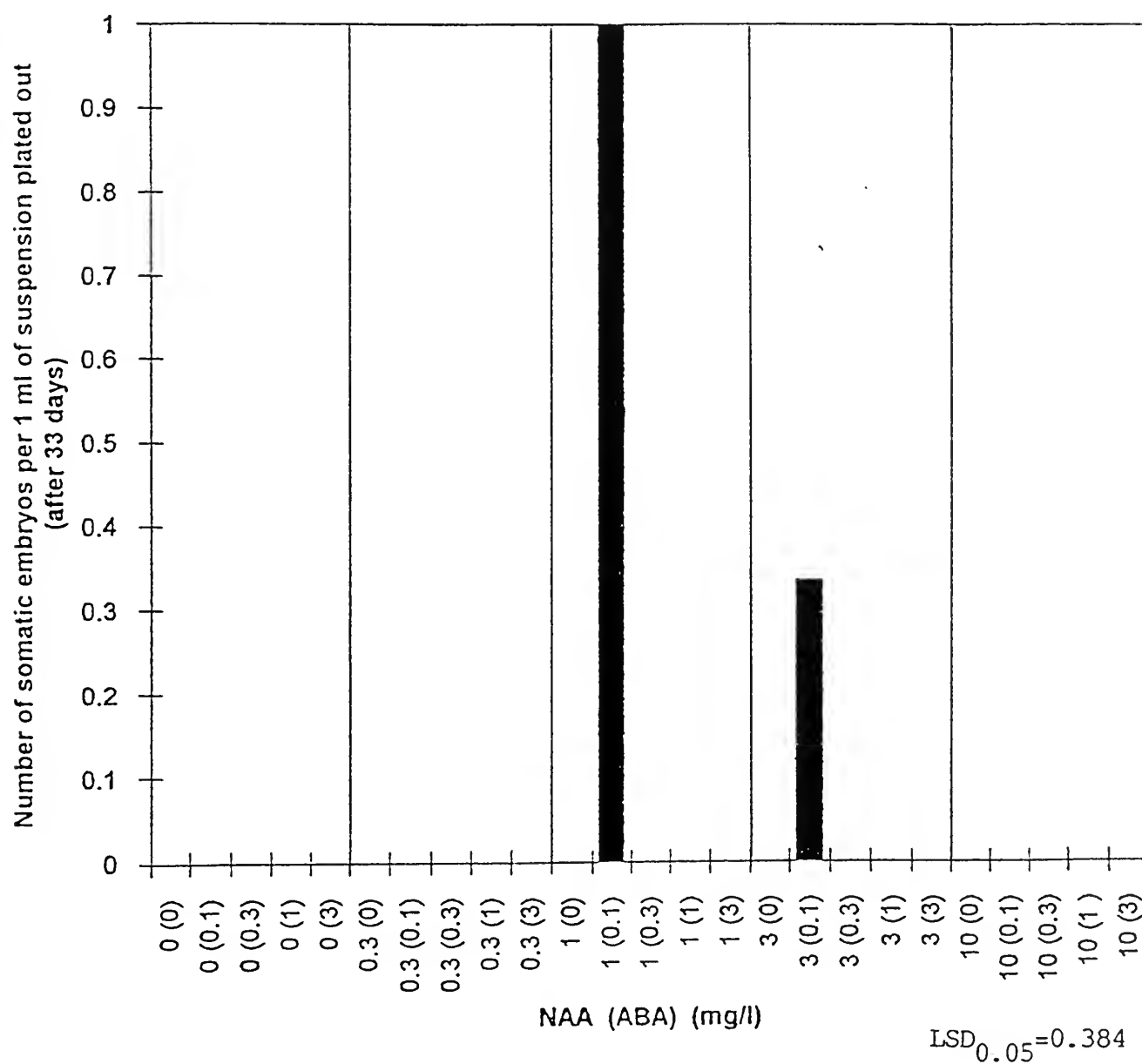


Fig. 3

Influence of NAA and ABA on somatic embryo production. Genotype LTR-41 callus initiated on MS medium with BA 1 mg/l.

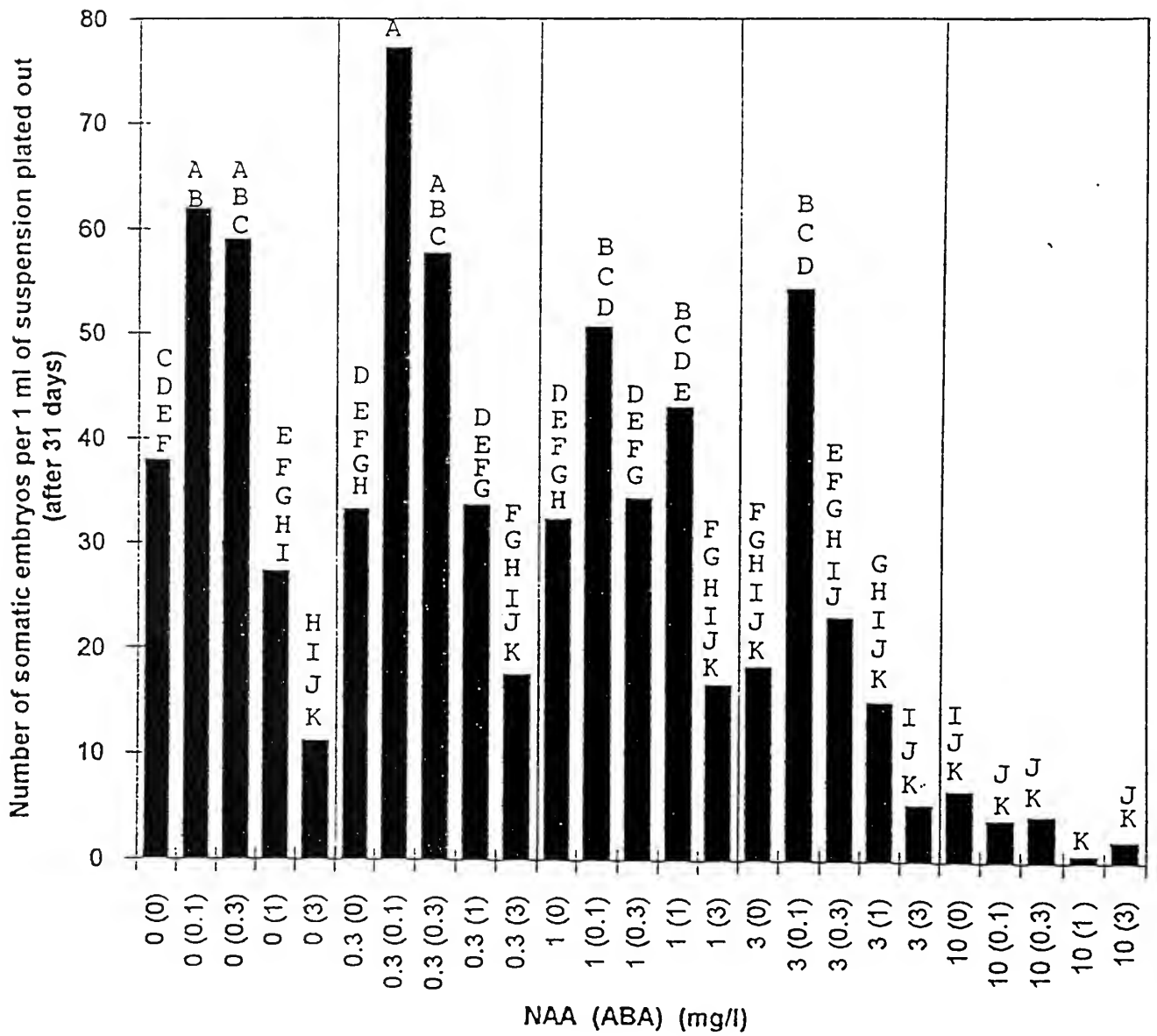


Fig. 4

Influence of NAA and ABA on combined fresh weight of somatic embryos and callus. Genotype LTR-41 callus initiated on MS medium with BA 1 mg/l.

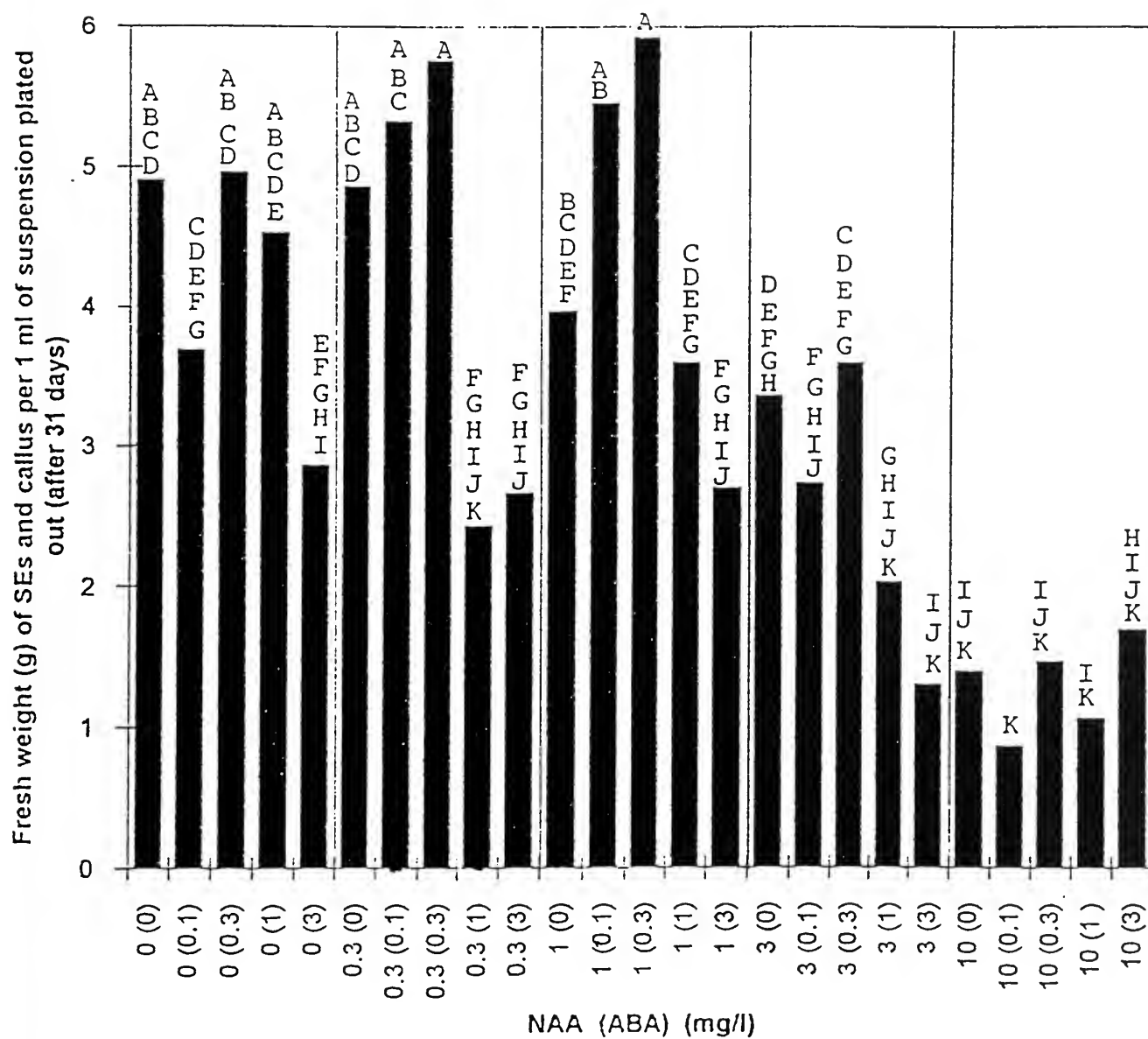


Fig. 5

Influence of 2,4-D and ABA on somatic embryo production.
Genotype LTR-41 callus initiated on MS medium with BA 1
mg/l.

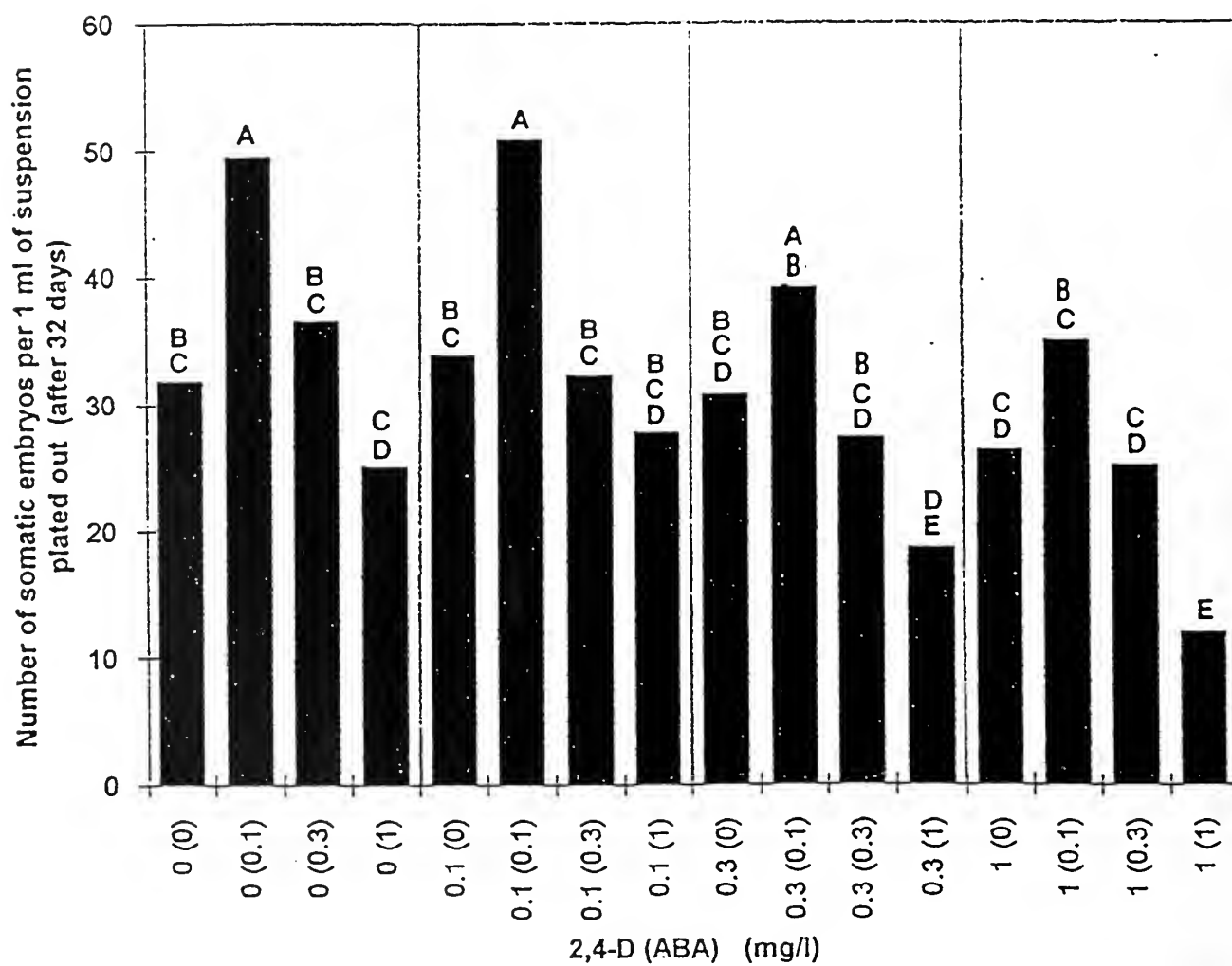


Fig. 6

Influence of BA and ABA on somatic embryo and shoot production. (REL-1)

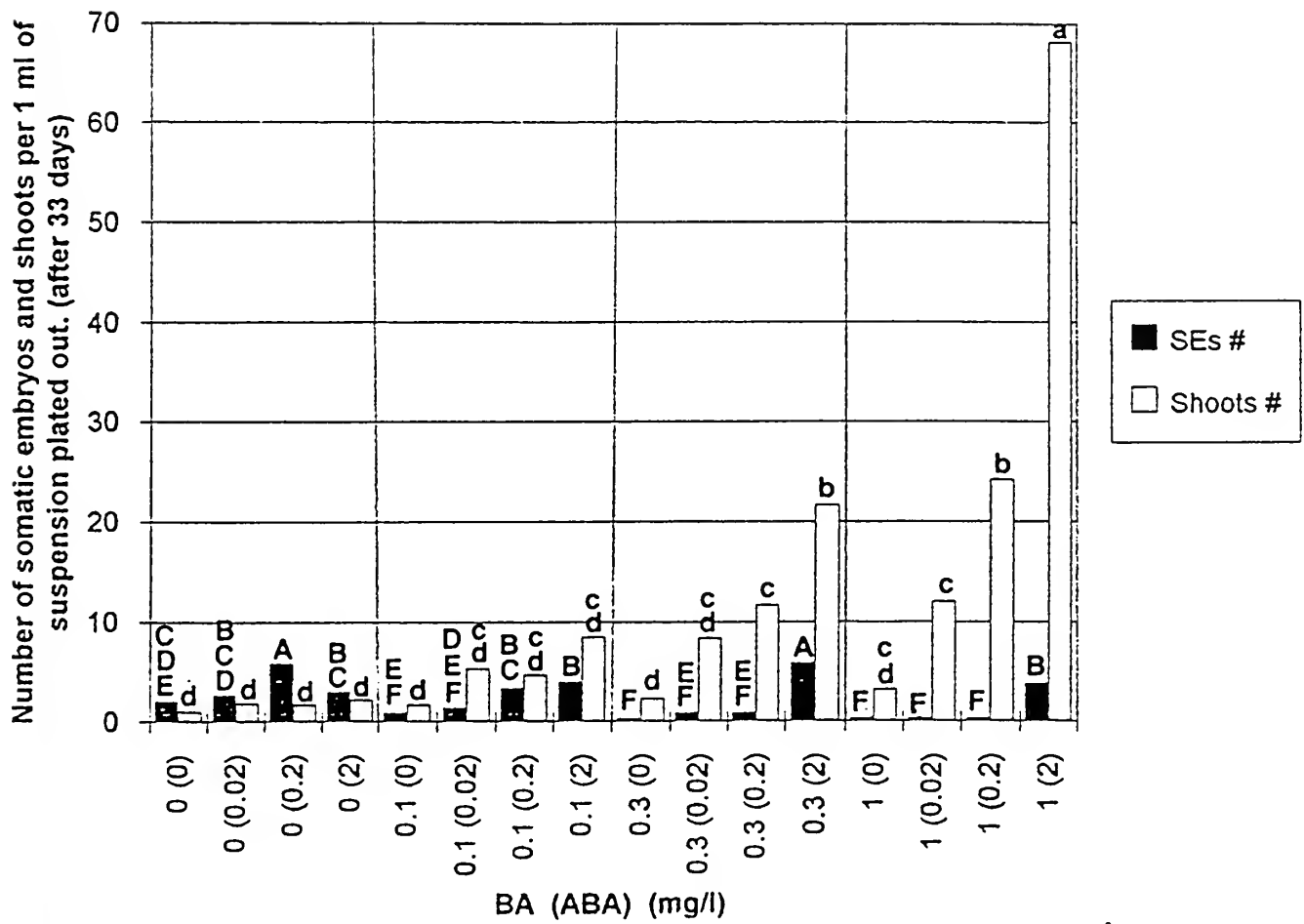


Fig. 7

Influence of BA and ABA on somatic embryo and shoot production. (LTR-41)

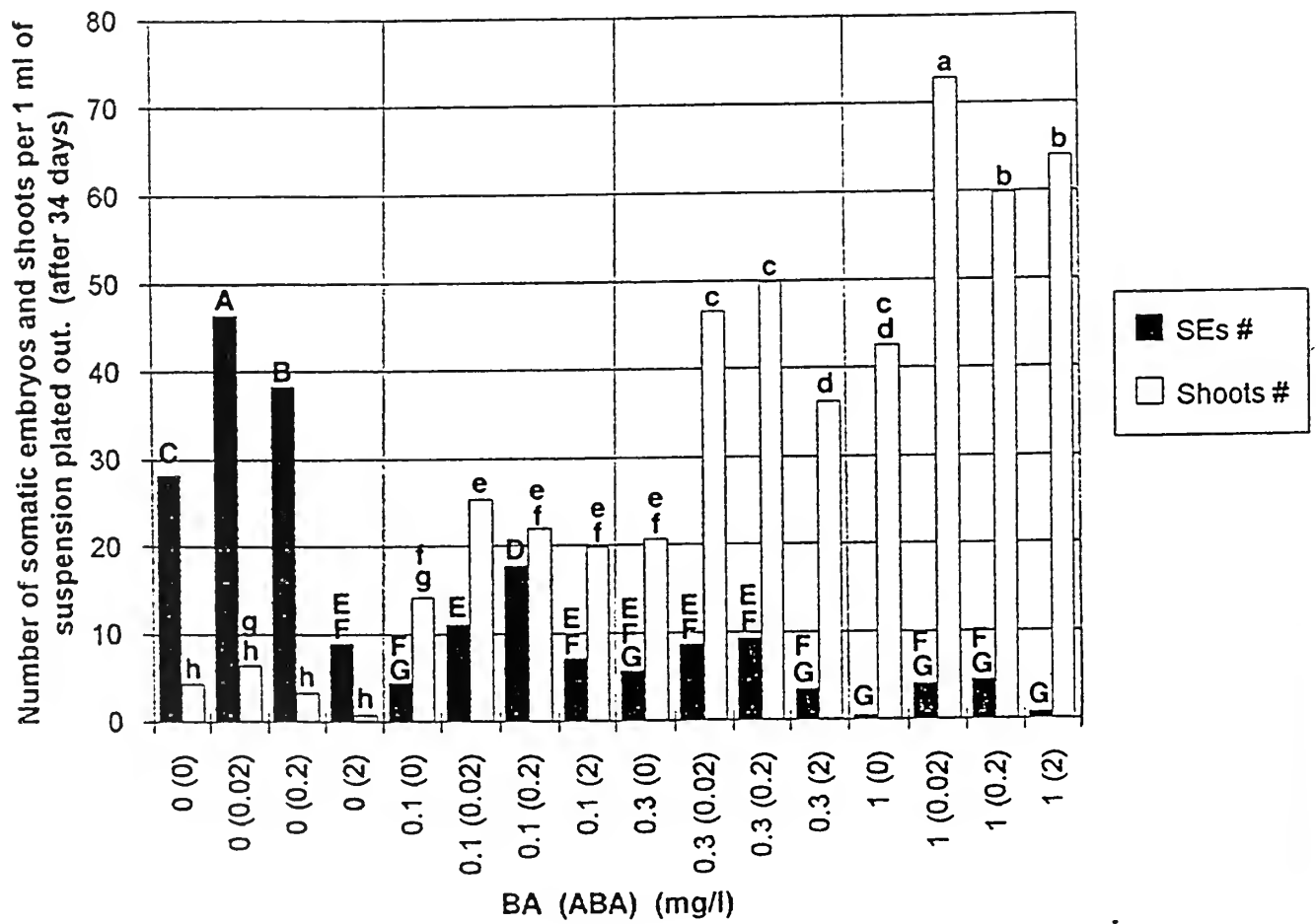


Fig. 8

Effect of sucrose concentration and presence of 0.2 mg/l ABA on somatic embryo production. Genotype LTR-41 callus initiated on hormone-free MS medium.

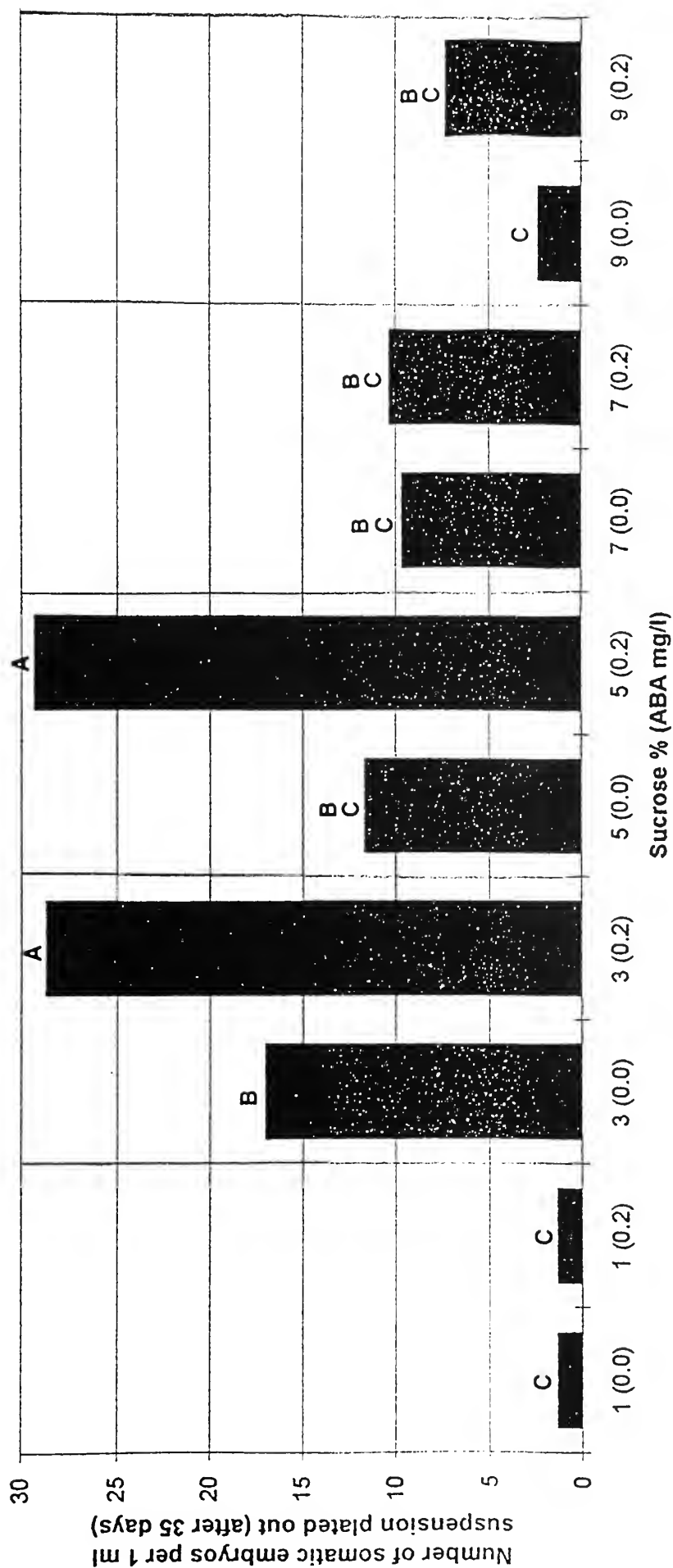


Fig. 9

REL-1 (after 34 days)

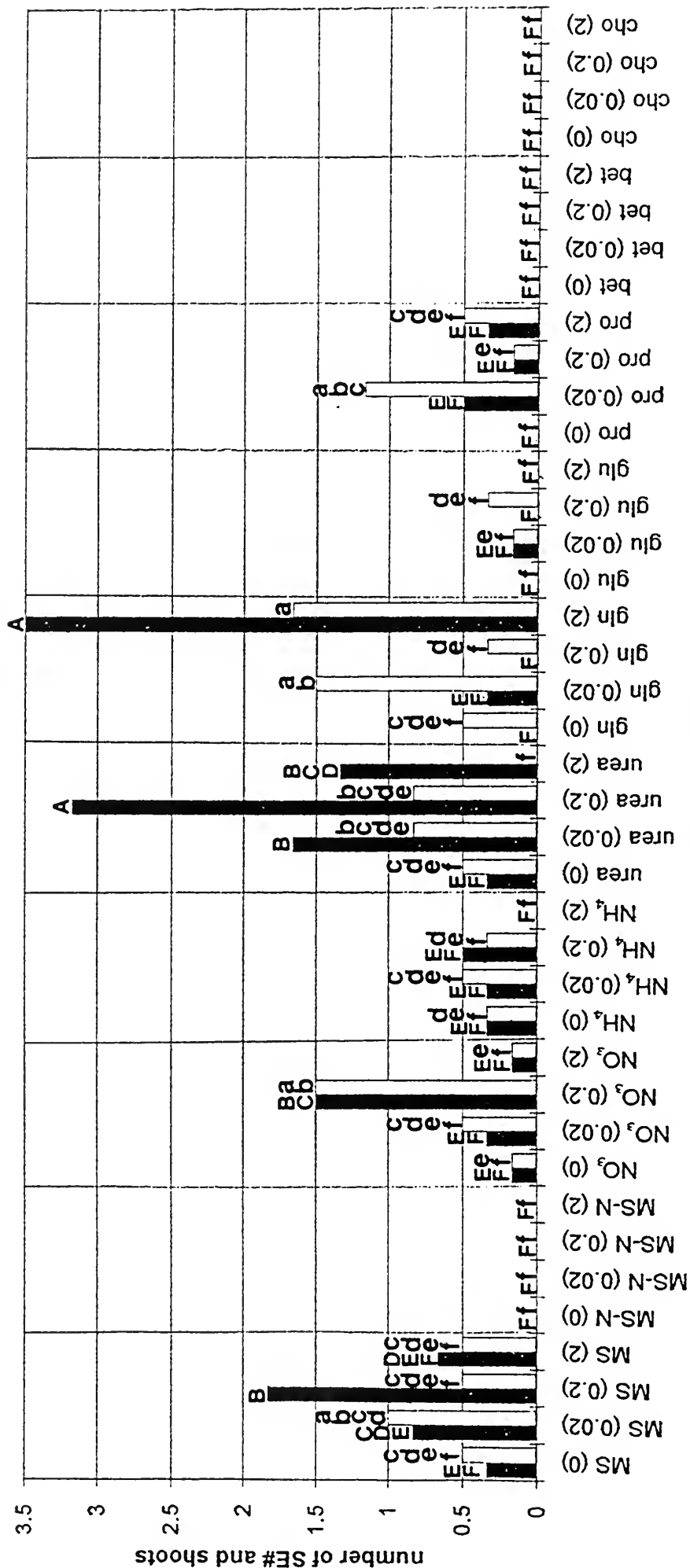
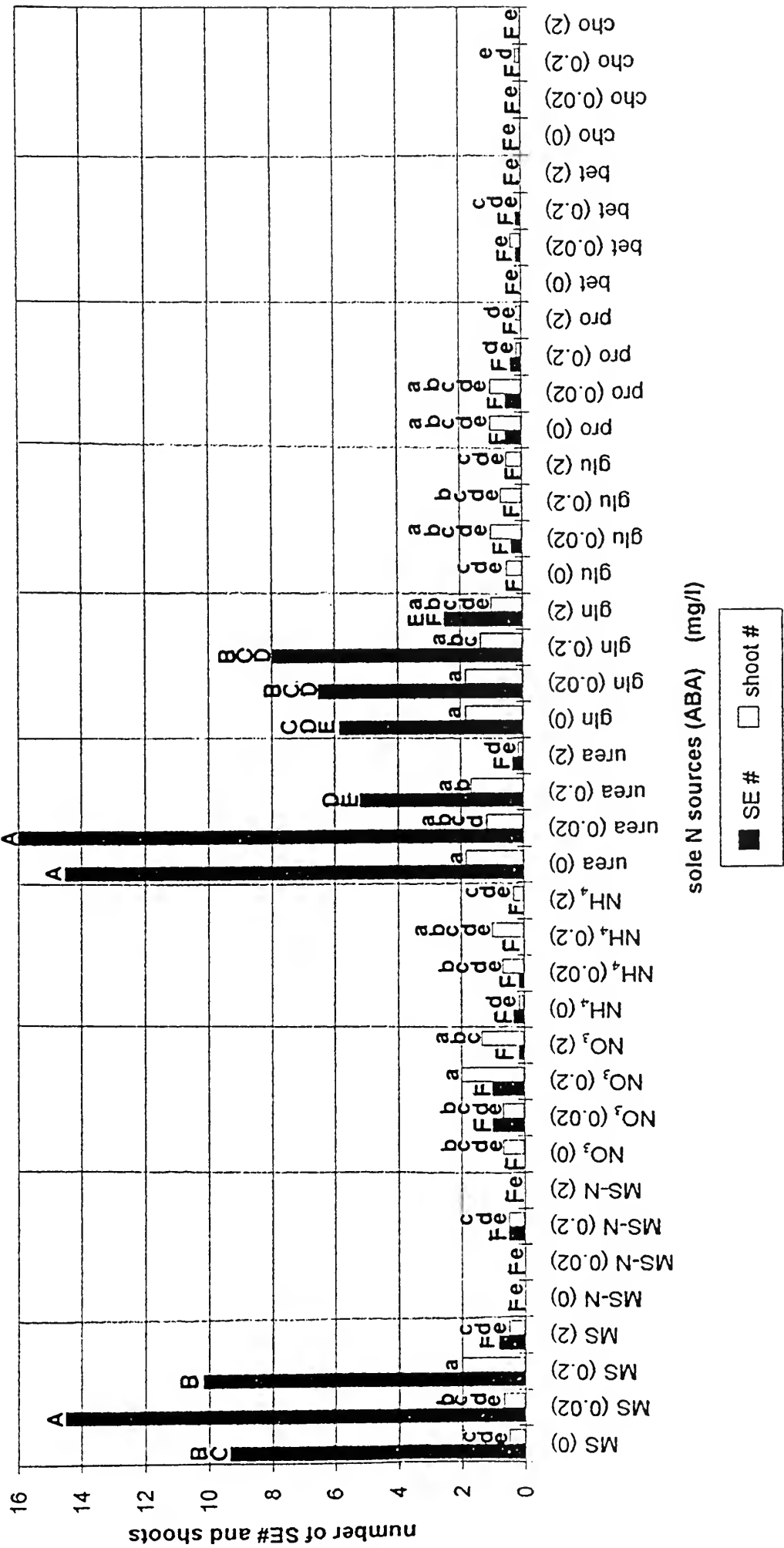


Fig. 10

LTR-41 (after 34 days)



PRODUCTION OF DIHYDROXY PHENOLIC PHYTOALEXINS BY SUGARBEETS IN RESPONSE TO CHALLENGE BY RHIZOCTONIA SOLANI

J. M. Halloin and L. Bramble

BSDF Project 720

Prior research (Halloin, J. M. 1994, Plant Science 99:223-228) established that sugarbeet roots expressing resistance to infection by *Rhizoctonia solani* (AG2-2) produce phenolic phytoalexins in the tissue immediately surrounding diseased tissues. These compounds react to form red-colored nitroso derivatives, demonstrating that they are o-dihydroxy phenolics. Previous attempts to isolate and characterize these phytoalexins have been unsuccessful. We made further attempts to isolate and characterize the phytoalexins.

Nitroso-reactive materials were removed from induced, freeze-dried tissues by exhaustive extraction with methanol (10-12 successive extractions, over 3 to 4 days). Methanol soluble materials were reduced in volume and spotted on thin layer chromatography (TLC) plates and the plates developed with various solvents. Chromatography on silica gel plates with chloroform:methanol (2:1, v:v) revealed four spots, one of which was relatively non polar and moved near the solvent front; the others were polar, and remained near the origin. The relative mobilities of these materials were reversed by TLC on C-18 plates with acetonitrile:water (70:30, v:v) as the solvent.

Small amounts of the four compounds were obtained by preparative TLC on silica gel and C-18 plates, and attempts were made to identify them by mass spectroscopy. The acquired spectra indicated that 1) the compounds were not pure, and 2) carbohydrates were present in all of the samples, suggesting that the phytoalexins may be glycosylated. Attempts to purify and characterize the phytoalexins continue.

Experimental attempts to isolate germplasms unusually high or low in production of the phytoalexins were continued, with one modification. Previously, induction was done by delivering a dilute solution of mercuric chloride into a hole drilled into tissue pieces cut from beets. Inoculum of *R. solani* grown on millet caryopses proved to be a more reliable inducer of phytoalexins and was used for all 1995 selections. Attempts at divergent, recurrent selection for intensity of phytoalexin production are expected to continue for the next two years in order to test the hypothesis that intensity and speed of the phytoalexin response is related to disease resistance.

USE OF SYSTEMIC ACQUIRED RESISTANCE FOR CONTROL OF SUGARBEET DISEASES

J. M. Halloin and J. J. Coombs

Systemic acquired resistance (SAR) is resistance to pathogens, induced in plants by materials that are themselves non-toxic to the pathogens (Malamy, et al., Uknes, et al.). The induced resistances typically are to a broad range of pathogens, including fungi,

bacteria, and viruses. The compound salicylic acid (SA) appears to act as a messenger for the resistance, moving throughout the plant from the region of induction (Delaney, et al.). The chemical 2,6-dichloroisonicotinic acid (INA), but not SA, was shown to induce SAR against *Cercospora* leaf spot of sugarbeets in greenhouse experiments (Nielsen, et al.), and chitosan derived from crab shells induced resistance to seedling disease when applied to tomato seeds (Benhamou, et al.). The experiments reported in this paper represent an initial attempt to determine if a variety of chemicals are able to induce detectable resistance to *Rhizoctonia* crown and root rot, or to *Cercospora* leaf spot of sugarbeets in the field. Also, seed treatment experiments were done to determine if SAR would be useful for enhancing the stand establishment and vigor of germinating seeds.

Materials and Methods

Seedling Establishment: Non treated, #3 seeds of two commercial sugarbeet hybrids, American Crystal 197 and Hillehog Monohy E-10 were obtained from R. Zielke, Michigan Sugar Company. Preliminary experiments determined that 50 g of seeds would imbibe 10 ml of water within 30 minutes. Hence, chemicals were applied to seeds at the rate of 10 ml of aqueous solution per 50 g of seeds; solutions and seeds were tumbled in flasks for 30 minutes, until the seeds appeared dry. Imbibed seeds then were air-dried at 22°C for two days and packaged for planting. Control seeds were imbibed in water, and treatment chemicals were a 25% WP formulation of INA provided by R. Hammerschmidt, Michigan State University, and chitosan prepared by the methods of Benhomu, et al.

Plots were planted as randomized complete blocks with four replications in six plantings at five locations: single plantings at Ithaca, MI, Breckenridge, MI, Blissfield, MI, and the Bean and Beet Research Farm at Saginaw, MI, and two separate plantings on the Botany and Plant Pathology Research Farm, Michigan State University, East Lansing, MI. Stand counts were made approximately one month following planting. Ten plants were collected from each plot, dried at 50°C for 72 hours, and weighed. Results presented are the means of four replications of two varieties in six plantings.

***Rhizoctonia* crown and root rot:** The effect of foliar applications of the known resistance inducers Na salicylate and INA on crown and root rot was determined using the hybrids American Crystal 197 and Hillehog Monohy E-10 in a disease nursery at East Lansing, MI. Four replications were planted in a randomized complete block design. Individual plots were single rows 25' long and 28" apart; plants were thinned to approximately 8 inch spacing four weeks after planting. Chemicals were applied to plants as aqueous solutions containing 0.5% Tween 20, and a solution of Tween 20 alone served as a check. Plants were sprayed to the point of run-off days 7, 5, 3, and 1 prior to inoculation. Inoculum consisted of ground millet infected with *R. solani*, which was applied to the crowns of the sugarbeets just prior to layby. Roots were dug by hand in mid September and scored for disease on a scale of 0 = no

disease lesions to 4 = dead, or greater than 75 % of the root rotted.

Cercospora leaf spot: The effect of foliar applications of Na salicylate and INA on crown and root rot was determined using the moderately resistant hybrid Hilleshog Monohy E-10 and the highly susceptible variety Edda (supplied by J. Miller, Betaseed Corporation) in a disease nursery at East Lansing, MI. Six replications were planted in a randomized complete block design. Individual plots were single rows 25' long and 28" apart; plants were thinned to approximately 8 inch spacing four weeks after planting. Chemicals were applied to plants as aqueous solutions containing 0.5% Tween 20, and a solution of Tween 20 alone served as a check. Non sprayed plants served as another check. Plants were sprayed to the point of run-off days 7, 5, 3, and 1 prior to inoculation. When full leaf canopy was developed the plants were inoculated by hand dusting with finely ground *Cercospora*-infected leaves collected at the end of the 1994 season. Each plot in the disease nursery was scored for leaf spot severity on August 10 and August 24. Scores were on a basis of 0 = no disease to 9 = plants dead.

Results and Discussion

Seedling establishment: The experiments on seedling establishment were predicated on the assumption that SAR might provide broad spectrum disease resistance that would result in enhanced seedling size, since it would reduce the effects of seedling diseases and of "root nibbling organisms". The results presented in Table 1 provide no evidence of enhanced seedling vigor as a result of seed treatment with chemicals known to induce systemic resistance in other crops.

Rhizoctonia crown and root rot: Attempts to reduce the severity of crown and root rot of sugar beets through induction of systemic resistance proved unsuccessful. Disease in the *Rhizoctonia* crown and root rot nursery was sufficiently severe in 1996 that among "susceptible" varieties, most plants died, and nearly all survivors attained disease ratings of 4 (= 75% or more of the root and crown rotted). Thus ratings presented in Table 2 are percentages of plants surviving. Results of others (R. Hammerschmidt, J. Ryals, oral communications) indicate that systemic movement of SAR in plants is mostly acropetal, rather than basipetal. Thus, movement of the resistance from treated foliage to roots would not be expected.

Cercospora leaf spot: INA provided moderate protection of the partly resistant sugarbeet variety E10 up to approximately three weeks following treatment and inoculation (Table 3), but the protective effect had dissipated two weeks later. Salicylate, the putative messenger compound for SAR in many plants had no apparent effect as in inducer of resistance. This finding is in agreement with the report of greenhouse experiments by Nielsen et al.

Additional field experiments to explore the use of SAR to control *Cercospora* leaf spot of sugarbeets are planned for 1996.

Joint experiments with A. Cattanach and G. Smith (Fargo, ND) will test the efficacy of SAR for controlling the disease with natural infestations of the pathogen. Experiments at East Lansing, MI will repeat the 1995 experiments and attempt to improve formulations and application schedules for the inducing chemicals.

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We thank R. Zielke, Michigan Sugar Company; R. Carter, Great Lakes Sugar Company; and L. Hubble, Monitor Sugar Company for their assistance in planting plots for the seedling establishment tests, and Mr. R. Sims for his technical assistance.

Tables

Table 1. The effect of seed treatment with inducers of systemic acquired resistance on stand establishment and seedling dry weight.

Treatment	Concentration	% of Control	
		Stand	Plant wt.
Chitosan	0.02 mg/g	99	107
Chitosan	0.2 mg/g	101	110
INA	6.4 ug/g	96	100
INA	20 ug/g	103	106

Table 2. The effect of foliar treatment with inducers of systemic acquired resistance on survival of sugarbeet plants inoculated with *Rhizoctonia solani*. Foliage was sprayed to the point of run-off days 7, 5, 3 and 1 prior to inoculation.

Treatment	Concentration	Survival %
Tween 20 (Ck)	0.5 %	14
Na salicylate	32 ppm	16
	100 ppm	16
INA	32 ppm	18
	100 ppm	15

Table 3. The effect of foliar treatment with inducers of systemic acquired resistance on leaf spot severity of sugarbeet plants inoculated with *Cercospora beticola*. Foliage was sprayed to the point of run-off days 7, 5, 3 and 1 prior to inoculation. Disease ratings are on a basis of 0 = no disease, to 9 = plants dead.

Treatment	Disease Ratings			
	8/10/95		8/24/95	
	E10	Edda	E10	Edda
Untreated Control	3.25	4.00	4.75	6.75
Tween 20, 0.5 %	3.25	4.50	5.00	6.75
Na salicylate, 32 ppm	3.00	4.00	5.75	7.00
100 ppm	2.75	4.25	5.00	6.50
INA, 20 ppm	2.25	3.25	5.00	6.50
40 ppm	2.00	3.50	5.00	6.50

SUGARBEET RESEARCH

1995 Report

Section F

University of Idaho
Idaho

Dr. S. L. Hafez

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SUGARBEET CYST NEMATODE MANAGEMENT

Saad L. Hafez

INTRODUCTION

Sugarbeet cyst nematode management research for southwestern Idaho is constantly evolving. Additional studies were conducted in 1994 - 95 on the use of green manure (also called catch or trap crops) in management systems and their effects on subsequent sugarbeet growth. This report describes the results of field experiments showing higher sugarbeet root yield following green manure incorporation. Studies on the effect of crop planting date, which may be used to manipulate the actual amount of green manure produced and then incorporated, indicate that sugarbeet yield may be improved in some instances. Careful choice of green manure crop planting date may influence biomass accumulation and related effects on sugarbeet yield.

I. Effect of fall planted oil radish, mustard and buckwheat cultivars on sugarbeet root yields planted the following season in a sugarbeet cyst nematode-infested field.

'Adagio' oil radish (*Raphanus sativus* spp. *oleifera*), 'Metex' white mustard (*Sinapis alba*) or 'Tardo' buckwheat (*Fagopyrum esculentum*) was planted following wheat in a sugarbeet cyst nematode-infested field in the fall of 1994 at Parma, Idaho. The experimental design was a complete randomized block with five replications. Fallow was included as a control for comparison. All cultivars were mechanically chopped three months after planting. Sugarbeet ('HM-WS-90') was planted with and without the addition of Temik the following spring to evaluate the effect of the green manure and Temik on sugarbeet yield. Counter was applied at planting for maggot control.

Results (Table 1) indicate that the three crops when used as green manure will, in general, promote significantly higher sugarbeet yields the following year when compared to fallow. Yield increases were not significantly influenced by the addition of Temik.

Table 1. Effect of green manure crops in combination with aldicarb (Temik) on sugarbeet yield in a field infested with sugarbeet cyst nematode, Parma, 1995.

Crop	Without Temik	With Temik
<hr/>		
	<hr/> --root weight (tons/acre)-- <hr/>	
Oil radish ('Adagio')	26.7 c *	28.6 b
Mustard ('Metex')	32.5 a	32.7 a
Buckwheat ('Tardo')	28.1 b	29.9 b
No plant	24.7 c	--

*Means in a column followed by different letters are significantly different at the 0.05 level (FLSD).

II. Effect of early and late planting dates of green manure crops and the subsequent yield of sugarbeet.

Two planting dates (early, Aug. 9, 1994 and late, Aug. 25, 1994) of oil radish and mustard were established to determine optimum planting dates for management of sugarbeet cyst nematode in southwestern Idaho. Soil samples before planting in the fall and in the following spring were collected for nematode assay. Plant biomass samples were collected from each planting date. Both planting dates significantly reduced nematode populations and the early planting date provided greater biomass than the late planting date (Table 2).

Table 2. Effect of planting date on dry matter production of two green manure crops, Parma, 1994.

Planting date	Crop - Dry matter g/m ² †	
	Radish ('Adagio')	Mustard ('Metex')
Early (August 9)	833.3 a*	844.6 a
Late (August 25)	451.5 b	675.0 b

*Means in a column followed by the same letter are not significantly different ($\alpha=0.05$).

†Plant samples for dry matter were collected October 18, 1994.

Green manure from both early and late plantings of 'Metex' mustard and the late planting of 'Adagio' radish significantly increased the yield of sugarbeet over the fallow control the following season (Table 3). Percent sugar showed a higher trend with higher yield, but the differences were not statistically significant.

Table 3. Effect of green manure crop and planting date on sugarbeet root yield in a field infested with sugarbeet cyst nematode, Parma, 1995.

Crop	Planting date	Yield (tons acre ⁻¹)	% Sugar
Oil radish ('Adagio')	Early	26.7 b *	15.28 ^{NS}
	Late	29.9 a	15.96
Mustard ('Metex')	Early	32.5 a	15.70
	Late	30.5 a	15.51
Fallow	--	24.7 b	15.46

*Means in the same column followed by different letters are significantly different at $P = 0.05$ (FLSD). ^{NS} Not significant.

III. Growth of green manure crops as influenced by planting and soil incorporation date.

Optimum management of sugarbeet cyst nematode with green manure crops may depend on the amount of green manure (biomass) attained, which may be affected by planting date. Numerous tests are required with different crops under Idaho conditions to establish optimum management levels. The studies reported here indicate that, indeed, planting and soil incorporation (growth termination) dates strongly influence green manure production.

Both 'Adagio' oil radish and 'Metex' mustard, harvested October 5, 1995, produced higher fresh and dry root weights when planted August 3 (early) vs. August 29, 1995 (late) (Table 4). Oil radish produced more root biomass than mustard. A time - biomass accumulation study was also conducted (Table 5). Oil radish produced the highest forage biomass nine weeks after the early planting and remaining biomass declined at twelve weeks. This decline may have a physiological basis in the translocation of photosynthate to the roots in response to photoperiod. In addition, a shift from vegetative to reproductive growth may utilize energy for inflorescence development. Mustard showed a similar decline, but the magnitude was not as great. Biomass increased dramatically at the later planting between five and eight weeks of growth for both crops. Further studies are needed to determine the exact influences of planting date and growth period on sugarbeet cyst nematode management in different sugarbeet growing areas of Idaho.

Table 4. Fresh and dry root weights of two green manure crops harvested October 5, 1995 following two planting dates.

Crop	Planting date	Root weight	
		-fresh-	-dry-
		<u>--Tons acre⁻¹--</u>	
Oil radish ('Adagio')	8/03/95	6.0	0.42
	8/29/95	2.2	0.20
Mustard ('Metex')	8/03/95	1.5	0.30
	8/29/95	1.2	0.20

Table 5. Forage fresh and dry weights of 'Adagio' oil radish and 'Metex' mustard at two harvest dates following two planting dates, Parma, 1995.

Harvest date	Planting date	'Adagio' oil radish		'Metex' mustard	
		Fr. wt.	Dry wt.	Fr. wt.	Dry wt.
		--Tons acre ⁻¹ --			
Nine weeks	8/03/95	39.7	3.0	21.7	2.6
Five weeks	8/29/95	13.2	1.0	12.5	1.1
Twelve weeks	8/03/95	32.1	3.0	20.4	3.3
Eight weeks	8/29/95	18.6	2.2	22.4	2.5

SURVIVAL OF SUGARBEET CYST NEMATODE IN TARE DIRT COMPOST

Saad L. Hafez and Robert Rynk

INTRODUCTION

Millions of tons of tare dirt are generated annually from the sugarbeet harvest. Disposal of this large volume of tare dirt is expensive and poses problems where appropriate land is scarce. Furthermore, the organic matter and top soil qualities of tare dirt are lost when it is merely deposited on unproductive land. Good uses for tare dirt might be to return it to agricultural land, particularly land used for sugarbeet production, or as a salable commodity for use in home and commercial nursery operations. However, these uses are avoided because of the possibility of spreading nematodes and disease organisms.

Recent research has indicated that composting tare dirt may successfully destroy nematodes and produce a consistently textured soil amendment, free of beet pieces and odor. Tare dirt might be used productively on agricultural land without spreading diseases or nematodes after composting. In fact, some compost has been shown to suppress diseases. Additionally, tare dirt may be composted with surplus manure or onion culls. Both of these products are difficult and expensive to dispose of under normal circumstances. This report describes the survival of sugarbeet cyst nematode in tare dirt compost and compost mixtures in turned and unturned piles.

I. Survival of viable cysts and eggs and larvae of sugarbeet cyst nematode following tare dirt composting.

Procedure:

Tare dirt from commercial beet piles, known to be from fields infested with sugarbeet cyst nematode, was collected, mixed and placed in piles approximately 20 feet long, 10 feet wide and 5 feet high. Samples (10 per pile) for nematode analysis were taken at four dates over the course of the experiment. Various treatments included amending tare dirt with onion culls or manure before composting and mechanical turning of some of the piles during the composting process. The specific treatments were:

1. 100% Tare Dirt (TD)
2. 60% TD, 40% Onion Culls
3. 50% TD, 50% Manure
4. 33% TD, 67% Manure

The 50% tare dirt : 50% manure treatment was not included in the unturned piles.

Results:

Survival of viable cysts in tare dirt compost over four sampling dates in turned and unturned piles is shown in Figures 1 and 2, respectively. Figures 3 and 4 show the data expressed as survival of the total number of eggs and larvae. Cyst and egg and larvae content of the soil declined rapidly and immensely during the 10 month study. Survival in compost amended with onion culls or manure declined more than in unamended tare dirt over the early portion (fall

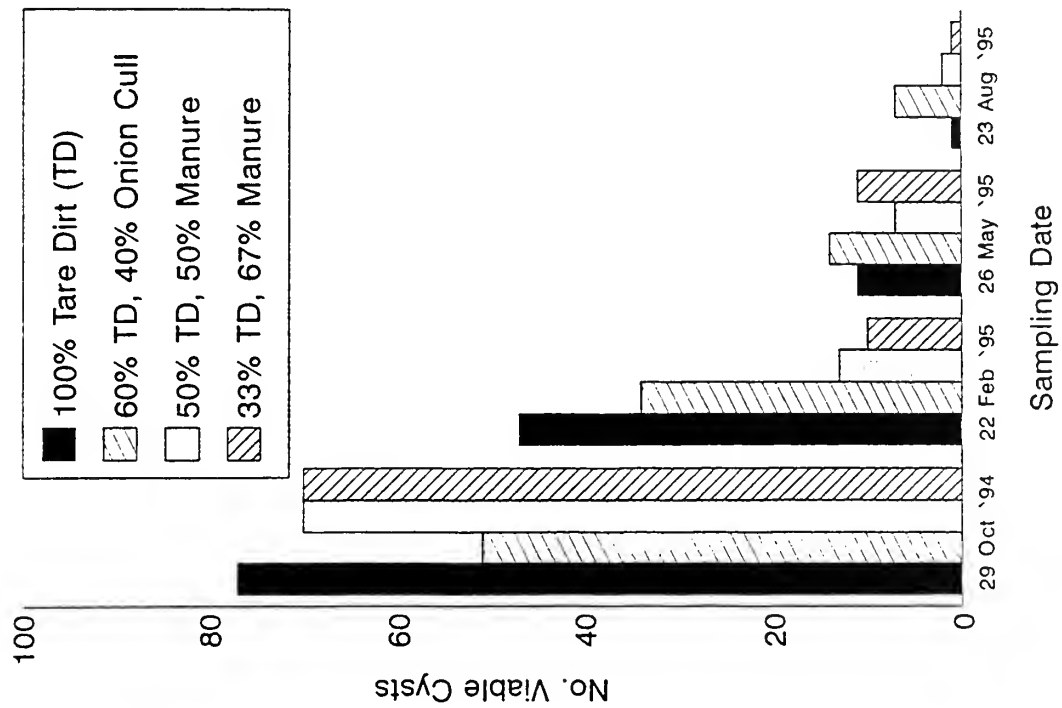


Figure 1. Survival of viable cysts in tare dirt compost, turned piles.

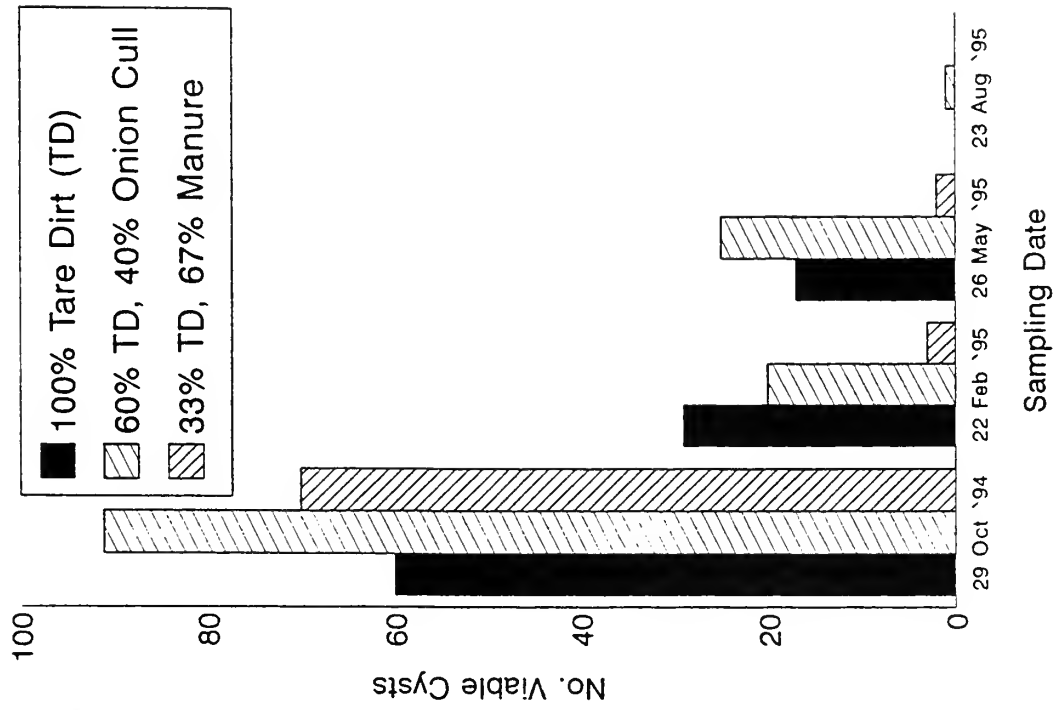


Figure 2. Survival of viable cysts in tare dirt compost, unturned piles.

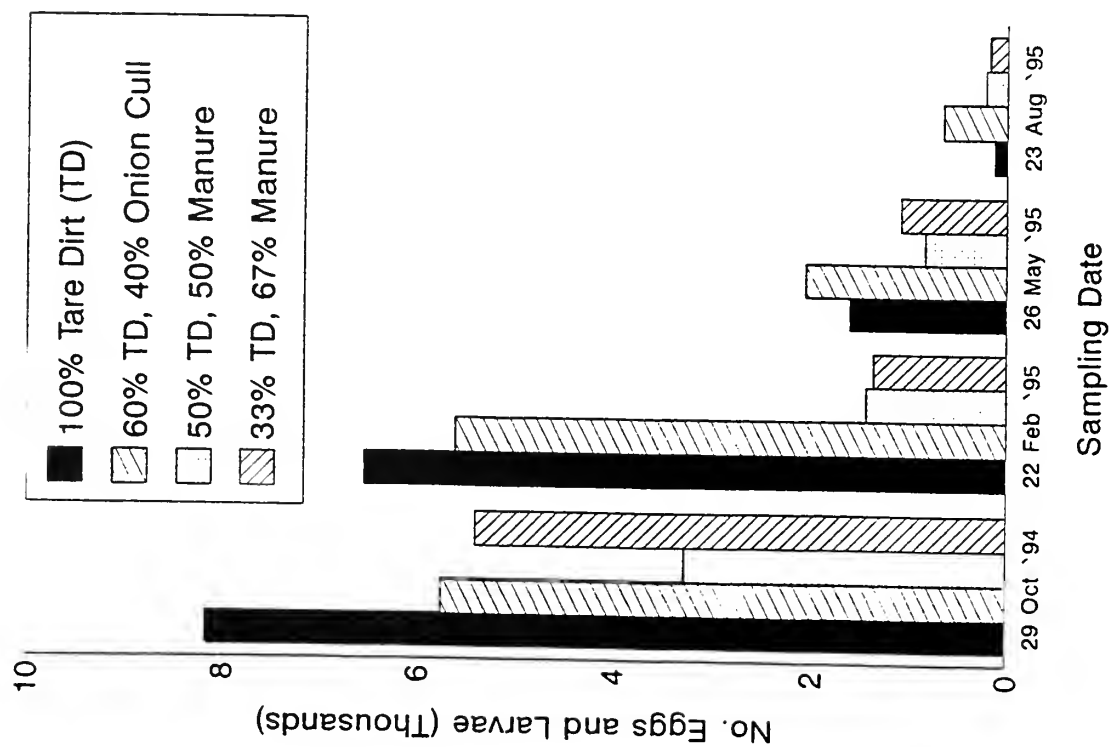


Figure 3. Survival of eggs and larvae in tare dirt compost, turned piles.

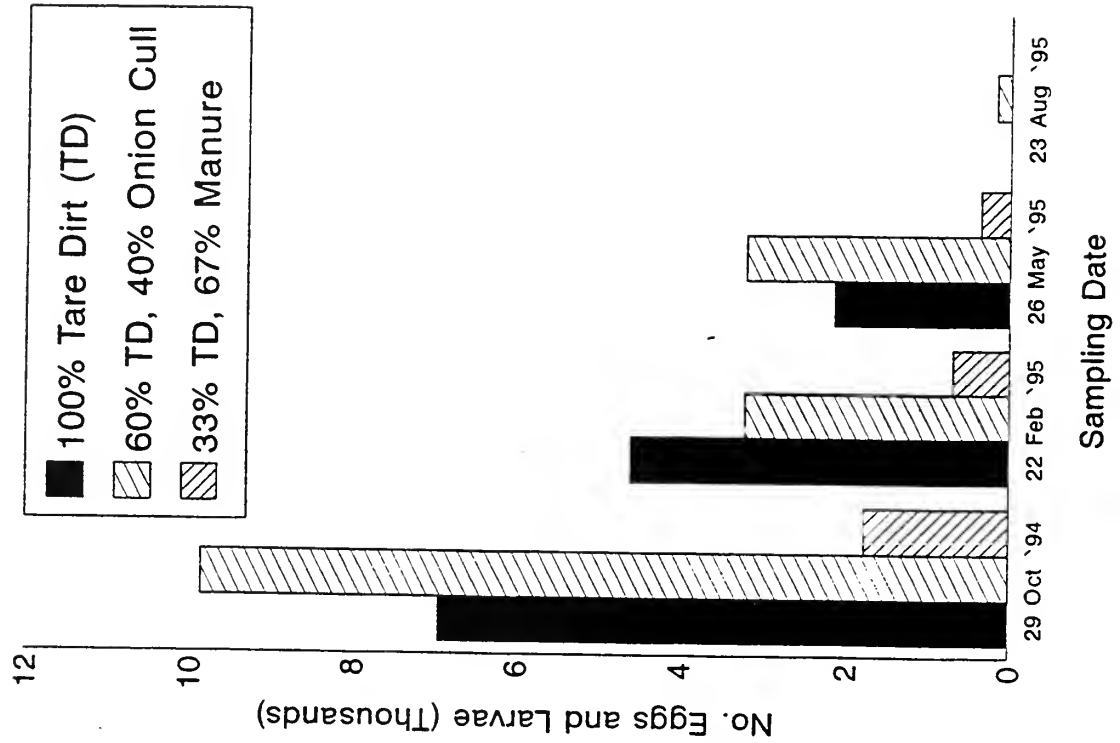


Figure 4. Survival of eggs and larvae in tare dirt compost, unturned piles.

and winter) of the experiment but not during spring and summer. Turning the piles was not necessary to allow composting to destroy sugarbeet cyst nematodes. Cyst and egg and larvae content in tare dirt alone and the 67% manure mixture was reduced by composting to zero in unturned piles, while some nematodes remained in the turned piles. Only the onion cull amended treatment contained sugarbeet cyst nematodes in unturned piles at the end of the testing period, while all treatments in turned piles contained residual cysts, eggs and larvae. The major advantages of turning seem to include the incorporation of the edges of the piles and thorough mixing of beet pieces for more complete decomposition.

II. Temperature of composting piles/windrows.

The aerobic decomposition of organic matter that occurs during composting generates considerable heat which raises the temperature of the composting materials. Because high temperatures are probably the primary mechanism by which nematodes are destroyed in composting materials, the temperatures attained during composting are very important. Furthermore, higher temperatures generally speed the composting rate.

Piles containing various combinations of tare dirt, onion culls and dairy manure were constructed at two sites, Filer and Parma, Idaho. Most piles received periodic turnings (with a special windrow turner in Parma and a with a backhoe in Filer). Other piles received no turning. All Piles were regularly monitored for temperature.

Temperature results were similar at both sites. The results show that tare dirt alone contains enough organic matter to initially self-heat to thermophillic temperatures (above 105° F) but not enough to sustain high temperatures for more than a week or two. Adding manure prolongs the heating stage but may also lower the maximum temperatures. Onion culls reduce temperatures and slow the process by adding unneeded moisture. However, the moisture provided by onion culls would be an advantage if composting takes place over summer.

III. Compost Characteristics

The compost piles established in Parma and Filer were sampled and analyzed for crop nutrients and organic matter. A composite sample was taken from each pile/windrow after the compost judged to be stable, approximately 10 months after composting was initiated.

Sugarbeet tare dirt with all combinations of manure and onion culls produced a compost with relatively low organic matter and nutrients (Table 1), that is relative to typical compost made from manures and green materials. This was due to the low organic and nutrient content of the tare dirt itself. Nitrogen content of the composts ranged from about 0.4 to 0.8%, increasing with higher proportions of manure in the original piles. The composts produced from piles/windrows receiving turning was consistent in texture and largely free of residual beet

Table 1. Nutrient and chemical characteristics of 10-month old composts, Parma and Filer, Idaho.

Treatment	pH	P μg/g	K μg/g	O.M. %	NO ₃ -N μg/g	NH ₄ -N μg/g	C %	H %	N %
<u>Parma, Idaho</u>									
<u>Turned:</u>									
100% Tare Dirt (TD)	8.3	160	1880	3.74	328.0	13.5	3.1	0.85	0.38
60% TD, 40% Onion culls (OC)	8.7	144	2610	4.53	79.6	91.0	3.3	0.85	0.44
50% TD, 50% Manure	9.1	789	6390	7.37	352.0	3.7	5.3	1.10	0.58
33% TD, 67% Manure	9.6	1160	11500	8.96	251.0	20.5	6.5	1.20	0.60
<u>Not Turned:</u>									
100% TD	8.6	141	3410	4.72	4.1	40.1	3.7	0.92	0.41
60% TD, 40% OC	8.8	162	4030	4.50	122.0	41.8	3.3	0.81	0.44
33% TD, 67% Manure	9.8	925	5220	7.70	209.0	41.6	5.8	1.10	0.59
<u>Filer, Idaho</u>									
<u>Turned:</u>									
100% TD	8.1	469	5020	5.18	395.0	24.6	4.8	0.87	0.44
50% TD, 50% Manure	8.7	2630	10700	14.60	224.0	55.1	10.0	1.50	0.87
67% TD, 33% Manure	8.4	1560	6230	9.84	332.0	26.5	7.8	1.20	0.68
80% TD, 20% Manure	8.4	1400	10000	9.44	149.0	36.3	6.9	1.10	0.60
100% Manure	8.7	4960	12300	15.70	488.0	30.1	15.0	2.20	1.32
<u>Not Turned:</u>									
100% TD	7.5	65	2800	5.91	944.0	47.6	4.6	0.91	0.35
67% TD, 33% Manure	8.1	1280	7760	14.40	488.0	20.7	13.0	1.80	0.95
80% TD, 20% Manure	7.5	296	4270	6.97	103.0	118.0	5.4	1.00	0.44

pieces. However, some turning appears to be necessary to get complete decomposition of beets within a year as the non-turned piles were not acceptably finished by September. Most of the decomposition of the turned piles occurred after the winter season so it may be advantageous to delay turning until the spring when conditions are less troublesome.

It appears that a mixture containing a large proportion of tare dirt creates a soil amendment that is equivalent to a rich top soil. However, potential users may not recognize it as compost, which usually has higher organic matter levels and a more fibrous texture.

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SUGARBEET RESEARCH

1995 Report

Section G

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Cooperation:

Imperial Holly - Hereford, Texas

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Abstracts of Papers Published or Approved for Publication

HARVESON, R. M., and C. M. RUSH. 1995. Evaluation of genetic variability among *Fusarium oxysporum* f. sp. *betae* isolates by vegetative compatibility. 1995 Ann. Mtg. Amer. Phytopath. Soc., Pittsburgh, PA, August 12-16, 1995.

Over a three-year period (1992-1994), 160 *Fusarium oxysporum* f. sp. *betae* isolates were collected from sugar beet and pigweed plants from seven counties in Texas. They were separated into two groups -- those causing tip rot and those causing only vascular necrosis. Of the 160 isolates, 132 were actually used for vegetative compatibility evaluations. Twenty-eight isolates were chosen as testers, and were paired in all possible combinations to determine the number of vegetative compatibility groups (VCGs) present. Six VCGs have been identified using the 28 testers. The remaining 104 isolates are being screened against one member of each of the 6 established VCGs. To date, 53 isolates have been assigned to VCG 1, with VCGs 2-6 containing 4, 13, 2, 2, and 2 isolates, respectively. No relationship exists between VCG and root rot symptom or host. Results suggest that these populations of *F. oxysporum* are endemic to Texas.

HEIDEL, G. B., and C. M. RUSH. 1996. Differential ELISA reactions among three furovirus isolates. 1996 Ann. Mtg. South. Div. Amer. Phytopath. Soc., Greensboro, NC, February 4-8, 1996.

Polyclonal antisera (ab) were developed to purified whole virus (whl) and denatured capsid (den) of beet necrotic yellow vein virus (BNYVV) and beet soilborne mosaic virus (BSBMV), two multiparticulate, rod-shaped viruses transmitted by *Polymyxa betae* (Keskin). BSBMV-NC (the original antigen for BSBMVab), BSBMV-RC (normally weakly-reacting when trapped and probed with BSBMVab-den) and BNYVV were tested to compare reactivity. By indirect DAS ELISA, in which wells were coated with unfractionated antiserum and virions were probed with biotinylated IgG of BNYVVab-den or BSBMVab-den, BSBMV-NC and BNYVV reacted positively against homologous ab-whl and ab-den and homologous ab-whl, respectively. By indirect ELISA, in which virions were coated to the wells and probed with unfractionated antiserum, BSBMV-NC, BSBMV-RC, and BNYVV reacted positively against homologous ab-den and ab-whl. Cross-reactivity was indicated between BSBMV and BNYVV when trapped by ab-whl.

LOVIC, B. R., and C. M. RUSH. 1995. BNYVV-related indigenous mild viral strains for biocontrol of rhizomania: Characterization of candidate isolates and production of inoculum for field testing. 1995 Ann. Mtg. Amer. Phytopath. Soc., Pittsburgh, PA, August 12-16, 1995.

Rhizomania of sugar beet is caused by beet necrotic yellow vein virus (BNYVV), a soilborne virus vectored by a plasmodiophorous fungus, *Polymyxa betae*. Several soilborne BNYVV-like yet serologically distinct viral strains have been identified in commercial sugar beet fields of Colorado, Texas, and Nebraska from plants exhibiting systemic leaf symptoms and apparently healthy roots. Four such isolates, representing at least two different serotypes, were tested for their pathogenicity to sugar beet and for their ability to protect plants against BNYVV under greenhouse conditions. The biocontrol strategy is based on adaptation of a recently described method (Phytopathology 83:1216-1219) for seed application of BNYVV in the form of viruliferous cystosori of *P. betae*. Growing sugar beet (cv. HH67) from seed in containers concurrently with infected plants exhibiting systemic symptoms proved to be an efficient way of producing inoculum for field testing.

RUSH, C. M., G. B. HEIDEL, and S. K. MANOHAR. 1995. Variation among isolates of beet soilborne mosaic virus. 1995 Ann. Mtg. Pacific Div. Amer. Phytopath. Soc., Jackson Hole, WY, June 16-18, 1995.

Beet soilborne mosaic virus (BSBMV) is similar to beet necrotic yellow vein virus (BNYVV), which causes rhizomania. The main difference between BNYVV and BSBMV is in symptom expression. Over the last two years, isolates of BSBMV that produce foliar symptoms on *Chenopodium quinoa*, which are similar to those produced by BNYVV, have been recovered from several states. Furthermore, BSBMV has been recovered from sugar beets in Texas exhibiting typical symptoms of rhizomania but BNYVV could not be detected. In 1994, two viral isolates, serologically distinct from BNYVV and BSBMV, were recovered from beets. However, when used as templates in rt-PCR with primers specific for BSBMV, the expected product was formed. Several primers developed specifically for BNYVV are able to amplify BSBMV rt-PCR products, and a near full length product from BSBMV RNA3 has been amplified. Sequence analysis of this product should help explain observed variation among isolates of BSBMV.

Papers Published Since Abstracted in Previous Report

RUSH, C. M., and G. B. HEIDEL. 1995. Furovirus diseases of sugar beets in the United States. Plant Dis. 79:868-875.

WINTER, S. R., and C. M. RUSH. 1995. Producing sugarbeets with high yield and quality in Texas. TAES Bull. B-1722.

ETIOLOGY AND EPIDEMIOLOGY OF THE RHIZOMANIA DISEASE COMPLEX BSDF Project 503

BNYVV - BSBMV 1995 FIELD STUDY

C. M. Rush and G. B. Heidel

Since the discovery of beet soil borne mosaic virus (BSBMV) in 1986, there have been numerous questions concerning its genetic relation to BNYVV, whether it was damaging to sugar beets and whether it had any effect on incidence or severity of *Rhizomania*. Early studies of BSBMV indicated that the virus is very closely related to BNYVV and possibly even a mild strain. Since BSBMV is so closely related to BNYVV, there is a possibility that it could interfere with infection and multiplication of BNYVV. BSBMV is widespread throughout the Texas sugar beet growing area and, therefore, is important to Texas producers. In order to answer some of the questions concerning the impact of BSBMV on sugar beet root growth and purity and its effect on the incidence and severity of *Rhizomania*, field studies were initiated.

METHODS

Three isolates of BSBMV were used in this study and designated E, R, and H. These isolates were maintained in the greenhouse on sugar beet roots by growing infected plants in flats. Seed were planted in the flats with the infected plants, and the new seedlings would become naturally infected. These were allowed to grow for approximately 6-8 wk. The plants were then washed from the soil and used to reinfest new flats. In this way, large amounts of inoculum were prepared for each BSBMV isolate. Inoculum prepared in this manner was used to inoculate seeds for use in field studies. Inoculum of BNYVV was prepared in the same manner and used to inoculate field plots.

Twenty-five grams of roots from each BSBMV isolate were mixed with 250 g of seed and 250 ml of 2% methyl cellulose. In this way, the germinating seed are infected with the virus, which is in the roots that have been coated on the seed. The coated seed were dried and then packaged for planting (100 seed/packet for a 25 ft plot).

BNYVV infected roots that were grown in the greenhouse were used to inoculate field plots. The BNYVV inoculum was added to two 25 ft lengths of row for each plot, and the inoculum was added at different concentrations, i.e., undiluted, 1:4, 1:16, and a non-inoculated check (Fig. 1). After the soil was infested with the BNYVV inoculum, the BSBMV infested seed were planted. There were six replications of each seed treatment-inoculum density combination, and the seed treatments were completely randomized within infested and non-infested plots (Fig. 2). Plots were planted 14 May and harvested in mid-October.

RESULTS

The results of the BNYVV - BSBMV field study are presented in Tables 1-3. There were no interactions between BSBMV seed treatment and BNYVV inoculum density so data in Tables 1 and 2 is inclusive of all seed treatments and inoculum densities, respectively. As evidenced by the high disease rating in the BNYVV infested plots, environmental conditions were adequate for infection and disease development by BNYVV (Table 1). Plots infested with undiluted BNYVV or at the dilution of 1:4 had significantly higher disease ratings and lower yields than all other treatments. The 1:16 dilution also had a significantly higher disease rating and lower root yield than the controls. Plots that received no BNYVV but were planted with BSBMV infested seed had a lower root yield than treatments with no BNYVV or BSBMV, however, the disease ratings were not different. Table 2 shows the effects of the BSBMV seed treatments inclusive of all BNYVV inoculum dilutions. The interesting thing in this table is that the 'E' isolate of BSBMV had a significantly higher root yield than the uninfested seed. Table 3 shows the effects of seed treatment on disease and yield in undiluted BNYVV infested plots. Again, the 'E' isolate of BSBMV produced a significantly higher root yield and lower disease rating than the other two BSBMV seed treatments or the uninfested seed.

Table 1. BNYVV - BSBMV Field Study — BNYVV Inoculum Effects*

Inoculum	Final Yield ^a	Disease Rating ^b	Tons/Acre ^c	% Sugar
BNYVV-BSBMV CK	21.7 a	0.4 a	20.3 a	15.1 a
BNYVV-CK	21.5 a	0.5 a	18.5 b	14.8 a
BNYVV:1-16	18.7 b	1.4 b	16.1 c	13.7 b
BNYVV:1-4	17.9 b	2.5 c	11.5 d	13.0 c
BNYVV:1-0	14.8 c	2.7 c	10.0 d	13.1 c

^a Number of plants in an 8 ft 8 in. length of row. Means followed by the same letter are not significantly different according to Duncan's multiple range test.

^b Disease rating based on a 0-4 rating system, with 0 = no disease symptoms and 4 = roots extremely stunted with excessive bearding.

^c Estimated from an 8 ft 8 in. length of harvested row, i.e., 1/2000th of an acre, with rows at 30 in. spacing.

* There were no interactions between seed treatment and inoculum level. Values represent means by BNYVV inoculum treatments, inclusive of all seed treatments.

Table 2. BNYVV - BSBMV Field Study — Seed Treatment Effects*

Seed Treatment	Final Stand ^a	Disease Rating ^b	Tons/Acre ^c	% Sugar
E	20.5 a	1.2 a	16.8 a	14.0 a
R	18.8 ab	1.7 a	15.1 b	13.7 a
Control	18.0 b	1.5 a	14.6 b	14.0 a
H	18.3 b	1.7 a	14.4 b	14.0 a

^a Number of plants in an 8 ft 8 in. length of row. Means followed by the same letter are not significantly different according to Duncan's multiple range test.

^b Disease rating based on a 0-4 rating system, with 0 = no disease symptoms and 4 = roots extremely stunted with excessive bearding.

^c Estimated from an 8 ft 8 in. length of harvested row, i.e., 1/2000th of an acre, with rows at 30 in. spacing.

* There was no interaction between seed treatment and inoculum level. Values represent means by seed treatment, inclusive of all BNYVV inoculum treatments.

Table 3. Effects of BSBMV Seed Treatments on Disease Incidence and Yield in Undiluted BNYVV Plots

Seed Treatment	Final Stand ^a	Disease Rating ^b	Tons/Acre ^c	% Sugar
E	19.3 a	2.1 a	13.2 a	13.1 a
H	13.2 b	2.9 b	9.5 b	13.3 a
R	15.7 ab	2.9 b	9.3 b	12.9 a
Control	11.0 b	2.9 b	7.9 b	12.2 a

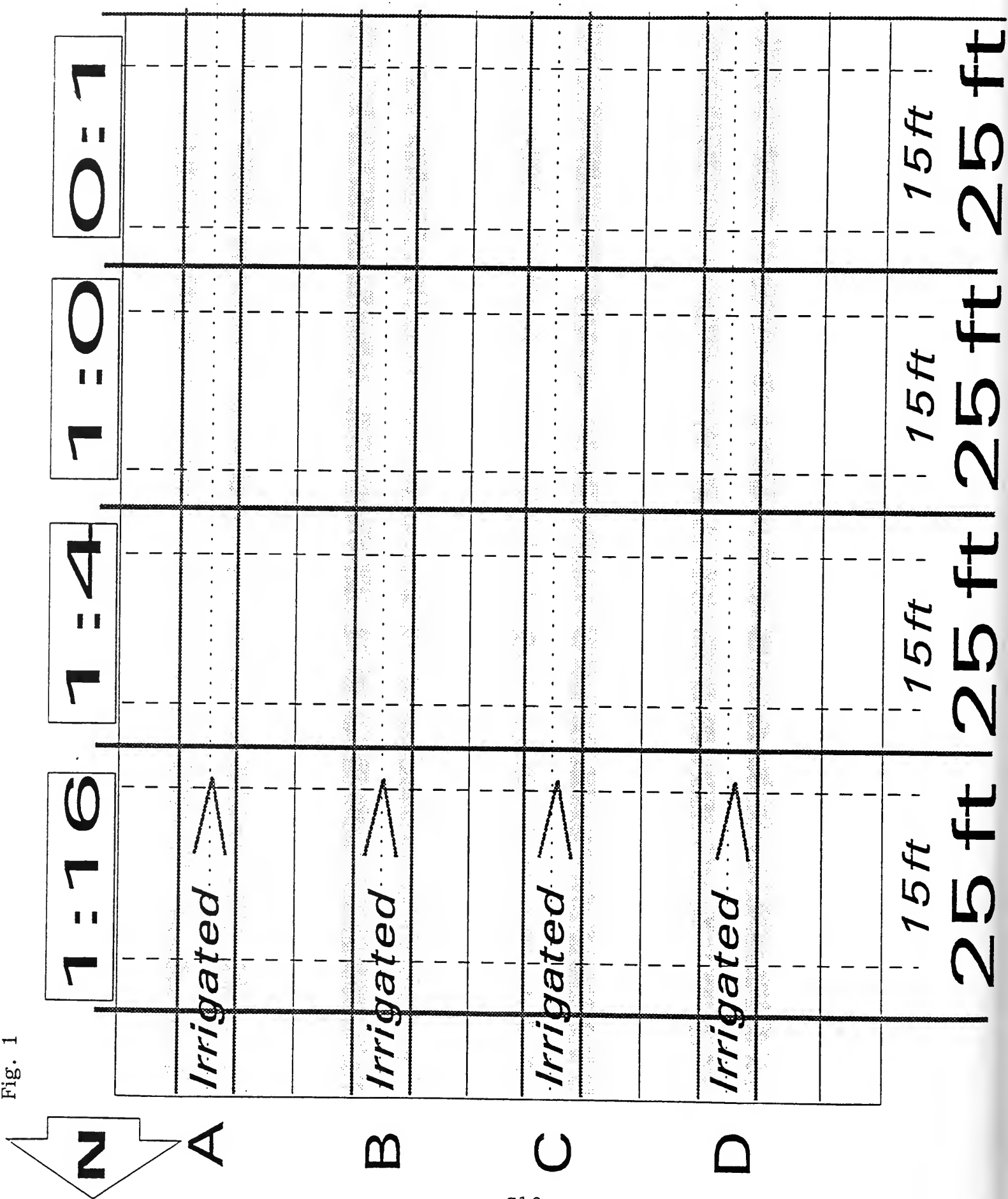
^a Number of plants in an 8 ft 8 in. length of row. Means followed by the same letter are not significantly different according to Duncan's multiple range test.

^b Disease rating based on a 0-4 rating system, with 0 = no disease symptoms and 4 = roots extremely stunted with excessive bearding.

^c Estimated from an 8 ft 8 in. length of harvested row, i.e., 1/2000th of an acre, with rows at 30 in. spacing.

The results of this test suggest that some isolates of BSBMV can offer a limited degree of protection against infection by BNYVV. Seed treated with the 'E' BSBMV isolate had higher mean yields at every BNYVV inoculum dilution and lower disease ratings, and the differences were statistically significant in some treatments. However, the level of protection was inadequate to produce a profitable sugar beet crop in the BNYVV infested plots. The good news is that BSBMV had very little detrimental effect on sugar beets. In most cases, plants from the BSBMV treated seed had disease ratings as low as non-treated seed and root yields were equal. Only when all treatments were combined did the BSBMV infested seed have an adverse effect on yield. When all BSBMV treatments were combined, the BSBMV treated plots yielded 1.8 tons less than non-treated plots (Table 1). This study will be repeated next year. The results are encouraging because they suggest that some isolates are better able to protect against BNYVV infection than others, and that the BSBMV isolates used in this study had minimal adverse effect on yield parameters.

Fig. 1



<div> <div>R = RC = C094-3</div> <div>H = Harkins = TX92-1</div> <div>E = Ed Amen = C094-1</div> <div>C = Control</div> <div>In = Infested</div> <div>Ni = Non-infested</div> </div>											
X	XI	XII									
Ni	In	Ni									
EHRCE	HRCE	HRCE									
I	II	III	IV	V	VI	VII	VIII	IX			
In	Ni	In	Ni	In	Ni	In	Ni	In			
EHRCH	HERH	CHCE	RECH	HRHC	CEHR	CEHR	CECR	RRHER			



Differential ELISA Reactions among Three Furovirus Isolates

G. B. Heidel and C. M. Rush

Polyclonal antisera (ab) were developed to purified whole virus (whl) and denatured capsid (den) of beet necrotic yellow vein virus (BNYVV) and beet soilborne mosaic virus (BSBMV), two multiparticulate, rod-shaped viruses transmitted by *Polymyxa betae* (Keskin). BSBMV-NC (the original antigen for BSBMVab), BSBMV-RC (normally weakly-reacting when trapped and probed with BSBMVab-den) and BNYVV were tested to compare reactivity. By indirect DAS ELISA, in which wells were coated with unfractionated antiserum and virions were probed with biotinylated IgG of BNYVVab-den or BSBMVab-den, BSBMV-NC and BNYVV reacted positively against homologous ab-whl and ab-den and homologous ab-whl, respectively. By indirect ELISA, in which virions were coated to the wells and probed with unfractionated antiserum, BSBMV-NC, BSBMV-RC and BNYVV reacted positively against homologous ab-den and ab-whl. Cross reactivity was indicated among isolates when probed by ab-whl.

INTRODUCTION

Beet necrotic yellow vein virus (BNYVV) and beet soilborne mosaic virus (BSBMV) are multiparticulate, rod-shaped viruses transmitted by *Polymyxa betae* Keskin, an obligate soilborne fungus. Though similar in morphology and mode of transmission, BNYVV and BSBMV are serologically different and vary in foliar and root symptom expression. BNYVV is the causal agent of rhizomania, a disease of sugar beet characterized by constriction of the main tap root, massive lateral root proliferation and stunting. Vein yellowing, followed by veinal necrosis, are diagnostic of BNYVV infection, but these symptoms are rarely observed in the field. Foliar symptoms caused by BSBMV in sugar beet typically include broader vein banding and mottling. BSBMV foliar symptoms, though not widespread in the field, are found more readily than those caused by BNYVV. Roots of beets infected by BSBMV can appear healthy, though sugar beets have been collected that exhibit symptoms normally associated with BNYVV but tested positive by ELISA only for BSBMV.

In October, 1994, sugar beets were collected from various fields in Colorado. Sample selection was based primarily on the presence of BSBMV-like foliar symptoms. Symptomatic leaf tissue was tested for BSBMV and BNYVV by an indirect DAS ELISA using IgG purified from antiserum developed to denatured BSBMV coat protein. In this test (referred to here as control DAS ELISA), samples are trapped by IgG and probed with biotinylated IgG. Of five isolates tested (LC, RC, Neal, Schaeffer and Amen), only two (Neal and Amen) were positive for BSBMV, and none was positive for BNYVV. Repeatedly, LC and RC, either in naturally-infected sugar beet leaf tissue or in leaves of *Chenopodium quinoa* Willd., a local lesion host of BSBMV, tested negative for BSBMV. A_{410} values of LC and RC typically were somewhat higher than those of healthy controls, but not high enough to consider as indicative of strong positive reactions.

For protein and PCR analysis, virus isolates were mechanically inoculated to *C. quinoa* from symptomatic sugar beet leaf tissue and purified using a modified version of the citrate buffer (minipurification) system. Capsid molecular weight was estimated by SDS-PAGE at 22-23 kDa. BSBMV capsid size has been estimated previously at 22.5 kDa, slightly larger than that reported (21 kDa) for BNYVV. RNA was extracted from the virus preparations and used for PCR analysis using primers specific to BSBMV. In previous studies, these primers directed the amplification of a 691 bp product from extracts of plants infected with BSBMV. Such a product was generated for every sample regardless of the isolate's serological reaction. RNA extracted from purified RC and LC virus preparations was electrophoresed in a formaldehyde denaturing agarose gel, and banding patterns were similar to that of the BNYVV control. BSBMV RNA sizes, determined previously, roughly correspond to those reported for BNYVV (6.8, 4.7, 1.8 and 1.5 kb). In shape, particles of the RC isolate are similar to those of BSBMV and BNYVV.

In western blot analysis, RC and LC, when probed with BSBMV IgG used routinely in control DAS ELISA tests (purified from antiserum developed to BSBMV denatured coat protein), reacted as strongly as the BSBMV positive control. Based on the differing serological reactions of RC and LC under denaturing (western blot) and nondenaturing (ELISA) conditions when probed with BSBMV antiserum developed to denatured coat protein, a test was devised to determine the reaction of an RC-type virus isolate (BSBMV-RC), a serologically typical (one that consistently tests positive when tested by control DAS ELISA) BSBMV isolate (BSBMV-NC) and BNYVV when tested by indirect and indirect DAS ELISA using antisera developed to BNYVV and BSBMV whole virus and denatured coat protein.

MATERIALS AND METHODS

BSBMV-NC and BNYVV were purified by a modified borate buffer purification method and used to develop polyclonal antisera (ab) to whole virus (ab-whl) or to denatured coat protein (ab-den). For indirect ELISA, *C. quinoa* infected with BSBMV-NC, BSBMV-RC or BNYVV was ground in carbonate buffer (1:10 [w/v]) and coated directly to the wells. Healthy *C. quinoa* was included as a negative control. After blocking with BWB (sodium phosphate-buffered saline, pH 7.6, with 0.05% [v/v] Tween 20 and 1% [w/v] bovine serum albumin), samples were probed with unfractionated BSBMV or BNYVV ab-whl or ab-den diluted 1:1000 (v/v) in BWB. Antisera were detected with protein A-alkaline phosphatase conjugate (0.5 mg/ml stock solution diluted 1:1000 [v/v] in BWB), and substrate (*p*-nitrophenyl phosphate) was added at 1.0 mg/ml. For indirect DAS ELISA, wells were coated with unfractionated BSBMV or BNYVV ab-whl or ab-den diluted 1:1000 (v/v) in 0.1 M phosphate-buffered saline, pH 7.1. After blocking, samples (ground in BWB, 1:10 [w/v]) were added to the plate and probed with biotinylated BSBMVab-den IgG or BNYVVab-den IgG (diluted to ca. 1 and 4 µg/ml, respectively, in BWB). The biotinylated secondary antibody was detected with avidin-conjugated alkaline phosphatase diluted to 0.16 µg/ml in BWB, and substrate was added at 1.0 mg/ml. BSBMV-RC, BSBMV-NC and BNYVV in *C. quinoa* were tested on the plate on which the indirect DAS ELISA was conducted by the indirect DAS ELISA (control DAS ELISA) used routinely in this lab to confirm their serological reaction. In the control DAS ELISA, wells were coated with

BSBMVab-den IgG or BNYVVab-den IgG at 1 or 4 µg/ml, respectively, and the remainder of the test was carried out as described for indirect DAS ELISA above.

RESULTS AND DISCUSSION

BSBMV-RC, BSBMV-NC and BNYVV reacted as expected when tested by control DAS ELISA (Table 1). BSBMV-NC and BNYVV reacted positively against homologous antisera, and there was no indication of cross reactivity. BSBMV-RC was negative when screened with BNYVVab-den IgG, and A_{410} values of samples tested with BSBMVab-den IgG, while somewhat higher than those of the healthy controls, were not high enough to consider as positive reactions.

Table 1. Absorbance (A_{410}) values of BSBMV-NC, BSBMV-RC and BNYVV when tested by control DAS ELISA

Sample	----- IgG -----	
	BSBMVab-den	BNYVVab-den
Healthy <i>C. quinoa</i>	0.000	0.004
BSBMV-RC	0.050	0.011
BNYVV	0.000	0.415
BSBMV-NC	0.826	0.011

By indirect ELISA, BSBMV-RC and BNYVV and BSBMV-RC and BSBMV-NC reacted positively when probed with BNYVVab-whl and BSBMVab-whl, respectively (Table 2). A slight reaction was detected by BSBMV-NC when probed by BNYVVab-whl, though the A_{410} value was not high enough to consider as a strong positive reaction. BSBMV-NC and BNYVV reacted positively when screened by homologous ab-den (though BNYVV reacted weakly), and BSBMV-RC was not detected by either ab-den. By indirect DAS ELISA, BSBMV-NC and BNYVV reacted positively against homologous ab-whl and ab-den (BNYVV reacted weakly), and there was no indication of cross reactivity among isolates (Table 3).

Table 2. Absorbance (A_{410}) value ratios of BSBMV-NC, BSBMV-RC and BNYVV in *C. quinoa* to healthy *C. quinoa* when tested with BSBMV and BNYVV ab-whl and ab-den antisera by indirect ELISA. Except where noted, ratios greater than three indicate a positive reaction.

A_{410} virus	A_{410} virus: A_{410} healthy <i>C. quinoa</i>	Virus \times antiserum
0.030	3.75 ^{a,d}	BSBMV-RC \times BSBMVab-den
0.004	0.50	BNYVV \times BSBMVab-den
0.182	22.8	BSBMV-NC \times BSBMVab-den
0.300	^b	BSBMV-RC \times BSBMVab-whl
0.031	^b	BNYVV \times BSBMVab-whl
0.329	^b	BSBMV-NC \times BSBMVab-whl
0.001	0.50	BSBMV-RC \times BNYVVab-den
0.052	26.0 ^c	BNYVV \times BNYVVab-den
0.001	0.50	BSBMV-NC \times BNYVVab-den
0.222	11.7	BSBMV-RC \times BNYVVab-whl
0.550	28.9	BNYVV \times BNYVVab-whl
0.071	3.74 ^a	BSBMV-NC \times BNYVVab-whl

^a Although ratios were greater than three, A_{410} values were too low to consider as strong positive reactions.

^b A_{410} values of healthy *C. quinoa* were < 0.00 . Values of 0.300 and 0.329 indicated positive reactions.

^c The A_{410} ratio was high, but virus A_{410} was lower than expected.

^d When antiserum was diluted 1:500, BSBMV-RC reacted more strongly (A_{410} virus = 0.116; A_{410} virus : A_{410} healthy *C. quinoa* = 7.73) when probed with BSBMVab-den.

Table 3. Absorbance (A_{410}) values of BSBMV-NC, BSBMV-RC and BNYVV in *C. quinoa* when tested with BSBMV and BNYVV ab-whl and ab-den antisera by DAS-ELISA.^a ‘+’ indicates a positive reaction.

A_{410} virus	Virus \times antiserum
0.001	BSBMV-RC \times BSBMVab-den
0.000	BNYVV \times BSBMVab-den
0.180 +	BSBMV-NC \times BSBMVab-den
0.009	BSBMV-RC \times BSBMVab-whl
0.000	BNYVV \times BSBMVab-whl
0.387 +	BSBMV-NC \times BSBMVab-whl
0.000	BSBMV-RC \times BNYVVab-den
0.079 ^b	BNYVV \times BNYVVab-den
0.000	BSBMV-NC \times BNYVVab-den
0.003	BSBMV-RC \times BNYVVab-whl
0.364 +	BNYVV \times BNYVVab-whl
0.002	BSBMV-NC \times BNYVVab-whl

^a Healthy *C. quinoa* A_{410} values were < 0.00 .

^b A_{410} was lower than expected.

Differences in serological reactivity among these isolates based on the nature of the serological test used to screen samples and configuration of the antigen used for antiserum production (whole virus or denatured coat protein) are significant in detecting and determining similarities and differences among isolates. Serological differences between BSBMV-RC and BSBMV-NC would likely have gone undetected if early testing was by indirect ELISA or relied solely on antiserum developed to whole virus particles. Results of serological tests can impact the everyday life of sugar beet growers as well. ELISA tests for BNYVV have been used in determining whether to effect a quarantine on a particular farm or a state's exports. Conflicting results from different labs using different ELISA methods can confuse issues. More work is needed to determine the pathogenicity of BSBMV-RC and BSBMV-NC and their effect on sugar beet growth. If these isolates are misidentified as BNYVV and their impact on sugar beet is minimal, quarantines may not be necessary.

Genetic Relatedness of BSBMV and BNYVV

C. M. Rush and G. B. Heidel

Over the last year, considerable time and effort have been spent in determining the relationship of BSBMV to BNYVV. BSBMV, closely related to BNYVV, may be a strain of BNYVV instead of a distinct virus as it is currently considered. As BSBMV has been studied, we have found that isolates are variable in their effect on beet growth. Various BSBMV isolates may react differently in ELISA tests. These topics are covered in other sections of this year's research report.

To determine the relationship of BSBMV and BNYVV, it is necessary to determine the genetic make-up of BSBMV and compare it to the known structure of BNYVV. Viruses are composed of a central core of building blocks called **nucleotides**, and this core is surrounded by a protein coat. There are only four nucleotides, but the sequence in which they are arranged makes each virus unique. The nucleotide arrangement of each virus is its genetic code, and differences in the nucleotide sequence account for differences in serological reaction (i.e., ELISA reaction) and pathogenicity, among other things. Three nucleotides code for an **amino acid** (there are 20 amino acids), and groups of amino acids make up **proteins**. Most biologically active compounds are proteins. When the nucleotide sequence of a virus is known, we can begin to understand why a certain virus does what it does to plants. When the nucleotide sequence of a virus is known, molecular methods can be used to develop powerful tools for detection and identification of that virus. These new methods have the potential to be many times more sensitive and accurate than current techniques. Therefore, this type of research has potential for both immediate and long-term benefits.

METHODS

The basic method for determining the nucleotide sequence of a virus is called **cloning**. The virus of interest, in this case BSBMV, is purified from the host plant and increased on an alternate host, such as *Chenopodium quinoa* (lambs quarter). The virus is then extracted from the plant material and purified. When enough purified virus is obtained, it can be cloned.

Cloning consists of mixing purified virus with genetic elements called **plasmids**. Plasmids are strings of nucleotides (of known sequence) derived from bacteria. When in their natural state, plasmids are in a circular configuration. During the cloning process, the nucleotide circle is broken at specific sites and is linearized. In this linear state, the nucleotide sequence of the purified virus is attached to the plasmid. The plasmid reforms into a circle containing the viral sequence. This entire process is called **ligation**.

After ligation, the circular plasmids containing the viral sequence are mixed with a certain type of bacteria able to incorporate the plasmids. When a bacterial cell incorporates a plasmid containing a viral sequence, the bacterial cell is said to be **transformed**. Transformed

bacterial cells multiply rapidly and, in doing so, increase the viral sequence being cloned. Within 24-hours, the bacteria will increase the viral sequence millions of times. After cloning, plasmids can be extracted from the transformed bacteria, and the viral nucleotide sequence can be determined. Although this process is relatively straightforward, it is not easy, and it is not a sure thing. The difficulty of the task is compounded when working with multi-component viruses such as BNYVV and BSBMV.

RESULTS

The results of BSBMV cloning and sequencing accomplished to-date are shown in Figs. 1 and 2 and Table 1. To date, approximately one-third of BSBMV RNA 1 and one-fourth of RNA 2 have been cloned. Sequence homology, i.e., similarity, between the portion of BSBMV RNA 1 cloned and BNYVV is approximately 90%, which is very high. Sequence homology of BSBMV and BNYVV on RNA 2 is also high, although some sections are more homologous than others (Fig. 1). BSBMV is more closely related to BNYVV than to other similar viruses. Although it is too early to say for sure, it appears that BSBMV is a strain of BNYVV and is not a distinct virus. From the sequence data obtained to date, probes can be made to detect and identify BSBMV. These probes should be helpful in differentiating BSBMV isolates and in distinguishing BNYVV from BSBMV.

Table 1. Homology of amino acid sequences from BSBMV with triple gene block regions of several other viruses.

BSBMV-PL	(42k) 100	(13k) 100	(15k) 99, 100*
BNYVV	(42k) 93, 97	(13k) 81, 90	(15k) 65, 78
BSBMV	(58k) 23, 46	(14k) 38, 58	(17k) 12, 44
NVMV	(39k) 23, 50	(13k) 39, 64	(ORF4) 28, 56
PCV	(51k) 22, 42	(14k) 34, 55	(17k) 16, 42
PMTV	(51k) 18, 43	(13k) 36, 55	(21k) 16, 44

* Percent identity and similarity

BNYVW RNA 1

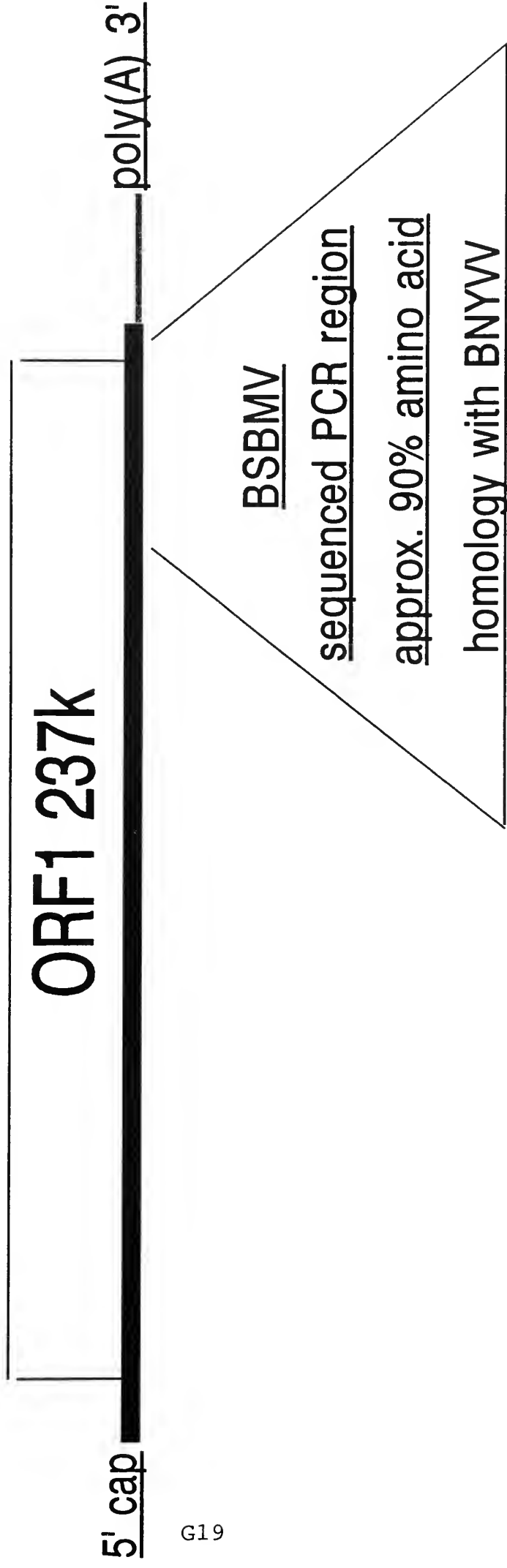
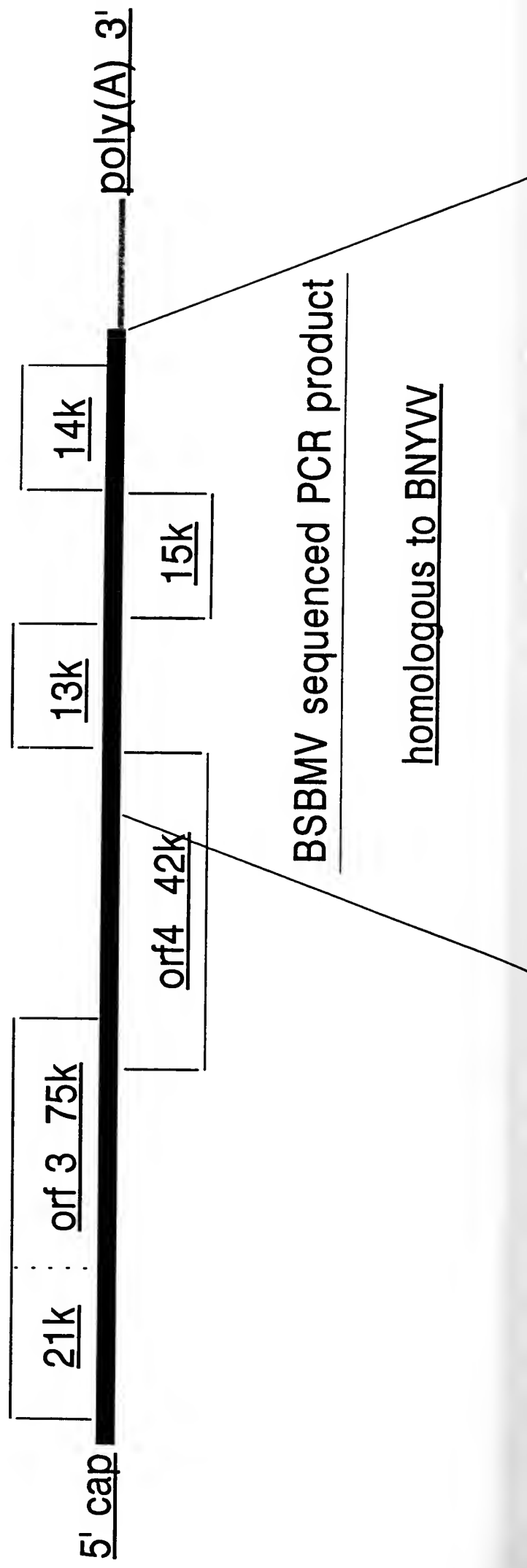


Fig. 2

BNYV RNA 2

triple gene block

cell-to-cell movement



SUGARBEET RESEARCH

1995 Report

Section H

University of Wisconsin
Madison, Wisconsin

Dr. I. L. Goldman

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PROJECT REPORT TO THE
BEET SUGAR DEVELOPMENT FOUNDATION
FY 1995-1996

Project Title: RAPD Marker Characterization of Selected Putative Genomic Regions Controlling Sucrose Synthesis in Sugarbeet

Project Leader: Dr. I.L. Goldman, Assistant Professor, University of Wisconsin-Madison, Department of Horticulture

Project Location: Plant Science Building, University of Wisconsin, Madison

Beginning Phase

The project began in the Summer of 1995. The goal of the beginning phase of the project was identification of useful RAPD primers for analysis of sugarbeet lines followed by DNA extraction and PCR amplification using the chosen primers. A sample of sugar beet lines of varying sucrose content were obtained from Dr. William Doley of the American Crystal Sugar Company. Seeds were planted in greenhouse flats. Leaf tissue was collected from 28 day old individual seedlings and frozen at -80°C. DNA was isolated from finely-ground, frozen leaf tissue using both a modified CTAB method (Saghai-Maroo et al. 1984) and an improved rapid DNA extraction method (see following page). Eagen (Eagen and Goldman, *In Press*) discussed decamer primers useful for amplification of beet DNA. At the initiation of this project, these primers were used to amplify genomic DNA of sugarbeet, and this amplification was successful. These primers will form the 'core set' for this investigation because of their reliability and repeatability in DNA amplification. These primers are listed and described in Table 1 below.

Table 1. Operon primer number and sequence, number of samples amplified, number of amplification products, and number of amplification products scored for each primer.

primer number	primer sequence	no. samples amplified	no. amplification products visualized	no. products typically scored
AA01	AGACGGCTCC	272	12	7
AA03	TTAGCGCCCC	252	15	8
AA10	TGGTCGGGTG	261	11	5
AA12	GGACCTCTTG	254	11	5
AA14	AACGGGCCAA	280	12	6
AB01	CCGTCGGTAG	264	6	3
AB09	GGGCGACTAC	261	12	9
AB11	GTGCGCAATG	277	8	5
AB14	AAGTGCGACC	254	11	7
AB15	CCTCCTTCTC	159	17	10

AB17	TCGCATCCAG	268	12	7
AC01	TCCCAGCAGA	219	11	5
AC06	CCAGAACGGA	267	19	10
AC15	TGCCGTGAGA	251	9	3
AC19	AGTCCGCCTG	262	11	3
AC20	ACGGAAGTGG	261	14	3
AD01	CAAAGGGCGG	259	15	7
AD02	CTGAACCGCT	267	9	3
AD04	GTAGGCCTCA	227	15	4
AD20	TCTTCGGAGG	282	4	1
AE02	TCGTTACCC	268	10	2
AE07	GTGTCAGTGG	263	15	7
AE09	TGCCACGAGG	282	9	3
AE10	CTGAAGCGCA	264	13	4
AF05	CCCGATCAGA	274	13	6
AF11	ACTGGGCCTC	266	16	8
AF15	CACGAACCTC	267	8	1
AG15	CCCACACGCA	242	14	7
AG17	AGCGGAAGTG	279	8	5
AI04	CTATCCTGCC	260	11	5
AI17	CCTCACGTCC	269	6	3

During the initial phase of this research, the DNA isolation protocol was modified and improved substantially over the conventional CTAB method. Modifications were made according to the protocol of Skroch and Nienhuis (University of Wisconsin-Madison) with minor modifications suggested by Eagen. The revised protocol is as follows:

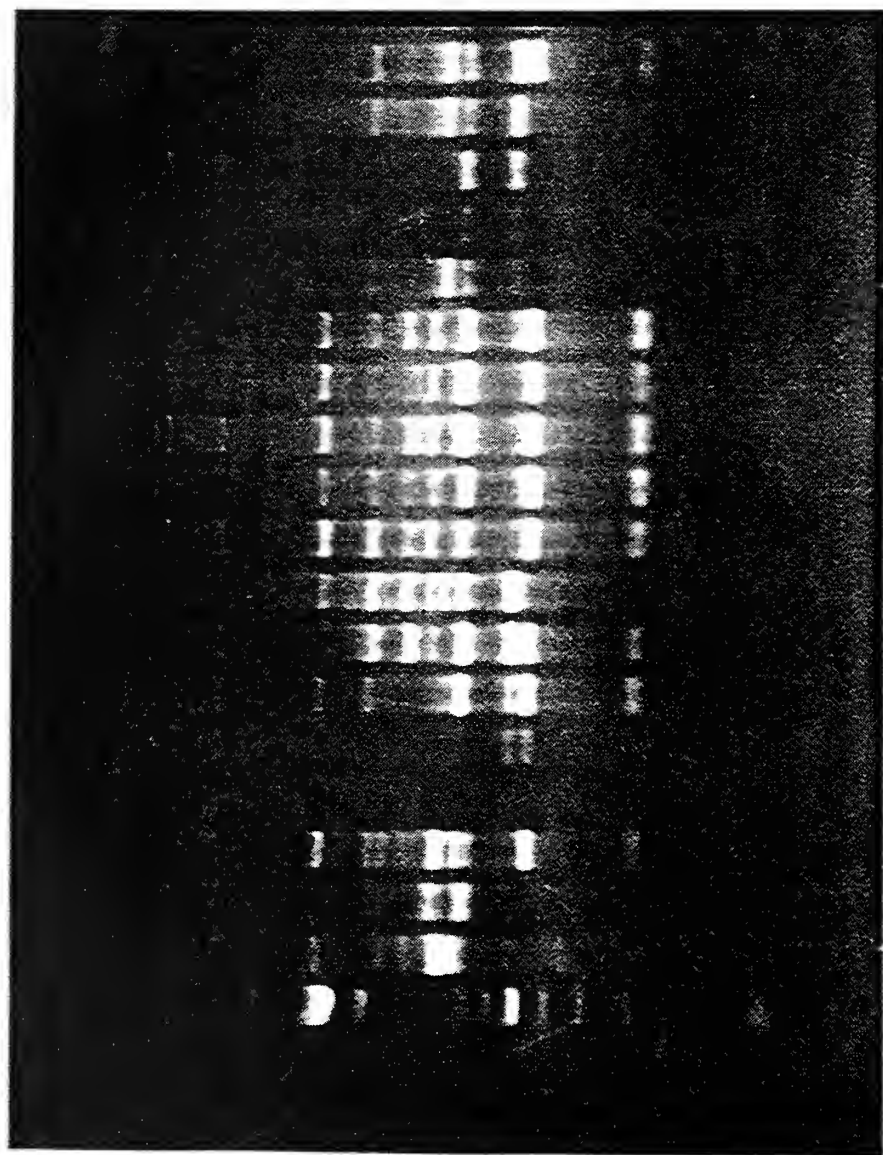
1. Harvest 0.75 g leaf tissue
2. Add 50 μ l extraction buffer to microcentrifuge tube
3. Grind using sharpened plastic rod
4. Add 500 μ l additional extraction buffer and vortex
5. Allow to soak at 65 C for 1 hour
6. Spin at 10,000 RPM for 10 minutes
7. Transfer supernatant to a new tube; precipitate nucleic acid with 6:1 ethanol:7.5M ammonium acetate.
8. Pellet nucleic acids by spinning for 5 minutes at 5000 RPM
9. Add 300 μ l TE
10. Add RNAase A to a final concentration of at least 100 μ g/ml at 37C for 1 hour
11. Spin at 10,000 RPM to pellet debris, transfer to a new tube

12. Precipitate DNA by adding 20:1 ethanol:3M sodium acetate. Allow to sit 30 minutes
13. Spin 5 minutes at 500 RPM to pellet DNA
14. Wash pellet with 70% ethanol
15. Collect pellet by spinning for 15 seconds at 14,000 RPM
16. Invert tubes and blot dry
17. Re-suspend in 50-200 µl TE

These thirty-one primers were chosen for amplification of the sugar beet samples. Reactions were run in 96-well Falcon assay plates according to protocols described in Paran et al. (1991). Each reaction contained 5 µl of DNA dilution (containing 5-10 ng of DNA), 12.8 µl of water, 2.5 µl of 10x buffer, 1.5 µl of 10 mM MgCl₂, 1.0 µl of 10 µM primer, 2.0 µl total of 1.25 mM each dNTP's and 0.2 µl of TAQ polymerase (2-5 units/µl). Two drops of mineral oil were added to assay plate wells to minimize evaporation. Controls containing no template DNA were added to each reaction plate. Amplification conditions were 1 minute at 94°C, 5 seconds at 94°C, 6 cycles of 30 seconds at 92°C, 1 minute at 36°C, 1 minute at 72°C and 36 cycles of 30 seconds at 92°C, 1 minute at 36°C and 1 minute at 72°C. Amplification reactions ran for 42 cycles in a MJ Research PTC-100 Programmable Thermal Controller. Amplification products were electrophoresed on 2% low EEO agarose gels. Bands were visualized via ethidium bromide staining. A 100 base pair ladder was used as a molecular weight standard on each gel. Amplification products in the form of fluorescent bands resulting from each primer-DNA combination were scored on a presence-absence basis. Scored amplification products were generally in the range of 275-2000 base pairs. Amplification reactions yielded from 1-10 discreet, scorable amplification products. Amplification products were designated by primer name followed by molecular weight.

Amplification of sugarbeet DNA samples was similar to that described by Eagen for red beet (Eagen and Goldman, In Press), however differences in amplification patterns were observed. Typical amplification patterns produced via PCR amplification for beet DNA samples are pictured in Figure 1 (see following page). Two additional shipments of sugarbeet seed samples were sent by Dr. W. Doley to our laboratory for analysis, the last of which was received within the last several months. We are currently isolating DNA from these samples and will be adding them to the database developed from previously screened samples. Overall analyses of the relationships among these lines will be conducted following the inclusion of these latter DNA samples into the database.

(Following page: PCR-mediated amplification of beet genomic DNA. Reaction shows up to six scorable amplified products.)



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